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DEALING WITH TECHNICAL PROBLEMS
RELATING TO THE PRODUCTS, PROCESSES AND INVESTIGATIONS OF
N.V. PHILIPS' GLOEILAMPENFABRIEKEN

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A TRANSPORTABLE TELEVISION INSTALLATION

by J. VAN DER MARK.

621.397.7

A description is given of a transportable apparatus suitable for the demonstration of television broadcasting and reception. The installation is housed in two automobile trailers, and is completely equipped for picture and sound reproduction of studio and outdoor scenes as well as of films.

In order to be able to give demonstrations of television at any desired place, the Philips Laboratory has built a portable apparatus, some particulars of which are given here.

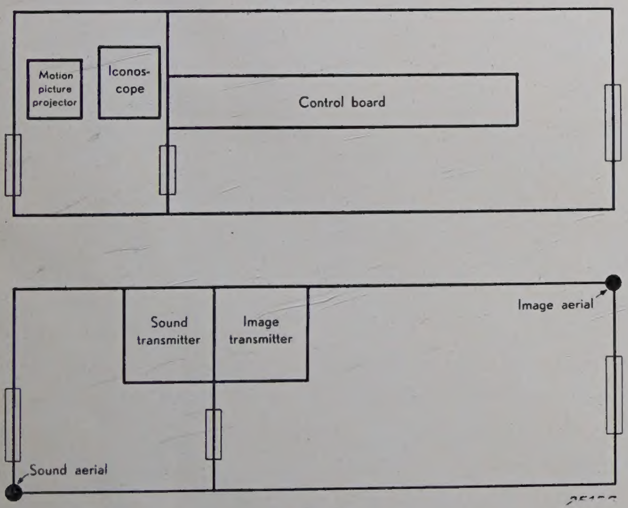

Fig. 1. Plan of the two automobile trailers for the portable television installation.

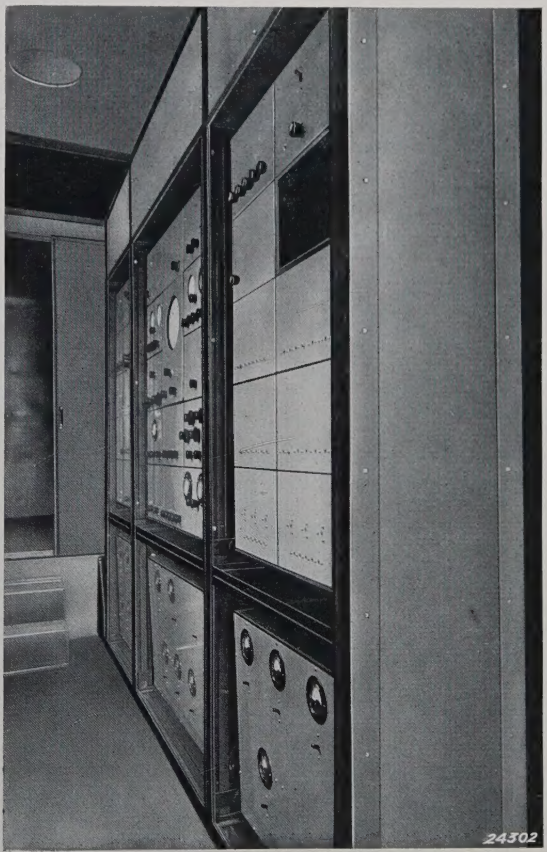

Fig. 2. Operation and control board. In the centre of the middle panel may be seen the front of the cathode-ray tube which shows the control picture. By means of the small cathode-ray tubes to the left and right of the big one, the picture voltages may be checked, in the first place in the form in which they are present in the cable to the transmitter car, and in the second place in the form present in the signal sent out from the transmitter, so that the correct functioning of the transmitter can also be supervised at this point in the first car.

The installation, which makes possible the transmission of studio and outdoor scenes as well as of films, is housed in two automobile trailers, each one having a floor surface of about 6 by 2 m. A plan of these two trailers is given in *fig. 1*. In the first is found the apparatus for the generator of the auxiliary signals and direct voltages necessary for the working of the iconoscope of the recording camera, in addition the apparatus for the conversion of the picture signals from the iconoscope and of the sound signals from the microphone or film, and finally the apparatus for monitoring the picture and sound obtained (*fig. 2*). Two kinds of pictures may be obtained: in a small fire-proof cabin (in the back-

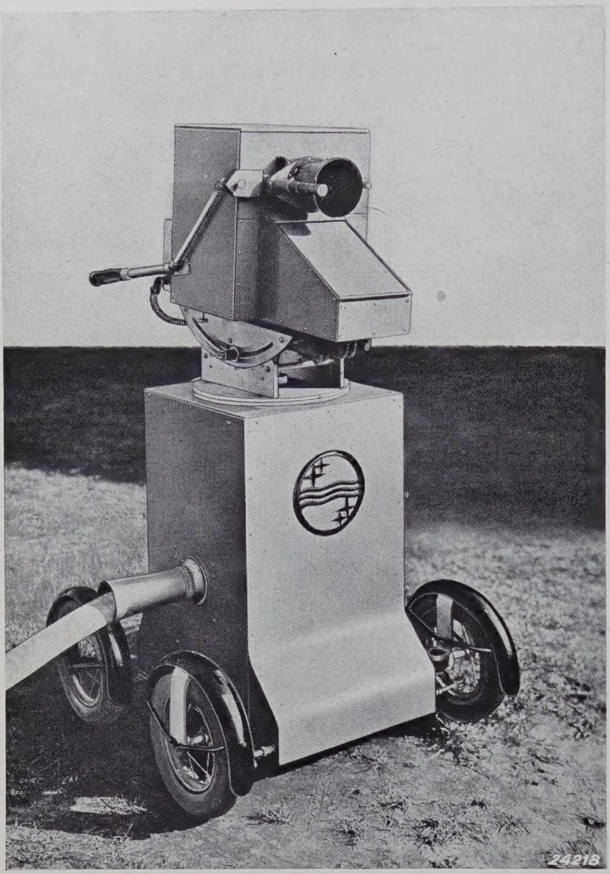

Fig. 3. The iconoscope camera for studio and outdoor work. The base of the camera is provided with a steering gear working on the front wheels, which can be operated by the left hand of the camera man. With his right hand he can direct the camera upon the object with a steering rod. The camera is mounted on its base in such a way that it rotates easily around horizontal and vertical axes. By twisting the handle of the steering rod the lens may be moved forward or back in order to focus the image on the mosaic of the iconoscope.

ground of fig. 2) there is an apparatus for the scanning of films by means of an iconoscope camera (*fig. 3*) which is connected with the trailer by a cable. *Fig. 4* shows the camera in use for outdoor scenes.

The signals from this first trailer are conducted through a cable to the second trailer, in which there are two small transmitters for broadcasting the picture (*fig. 6*) and the accompanying sound. For each transmitter there is an aerial at the top of a demountable mast about 10 m high. *Fig. 5* shows the aerials mounted on the television car.

The installation is suitable for the broadcasting of 25 pictures per second, with 405 or 567 lines per complete picture, while interlaced scanning is employed. (If 567 lines are used, a frequency spectrum must be dealt with which extends from about 50 cycles per second to about 5×10^6 cycles per second, for 405 lines the necessary frequency spectrum extends only to $2.5 \cdot 10^6$ cycles per second.

Since the circuit of a television transmitter has already been described in Philips techn. Rev. 1 p. 16 and 325, 1936, we shall not go into it again. Various refinements have been introduced, but the principle has remained the same.

A small studio set-up is also carried, which consists of an easily demountable framework of steel tubing (*fig. 7*) upon which five water-cooled super high pressure mercury lamps, each of 1 kW, can be attached wherever necessary. These have a closed water-cooling system.

During transport the studio set-up as well as the camera and the aerials can be carried in the transmitter car. All sensitive parts of the installation are sprung, so that they may withstand jarring.

The whole apparatus is fed with alternating current, no generators or accumulators need thus be transported to supply the necessary electrical energy, which must be taken from the local mains. The whole thus forms a complete low-powered television transmitting station. In giving demonstrations several receivers may be set up in the neighbourhood in order to exhibit the picture received "through the ether"; there is, however,

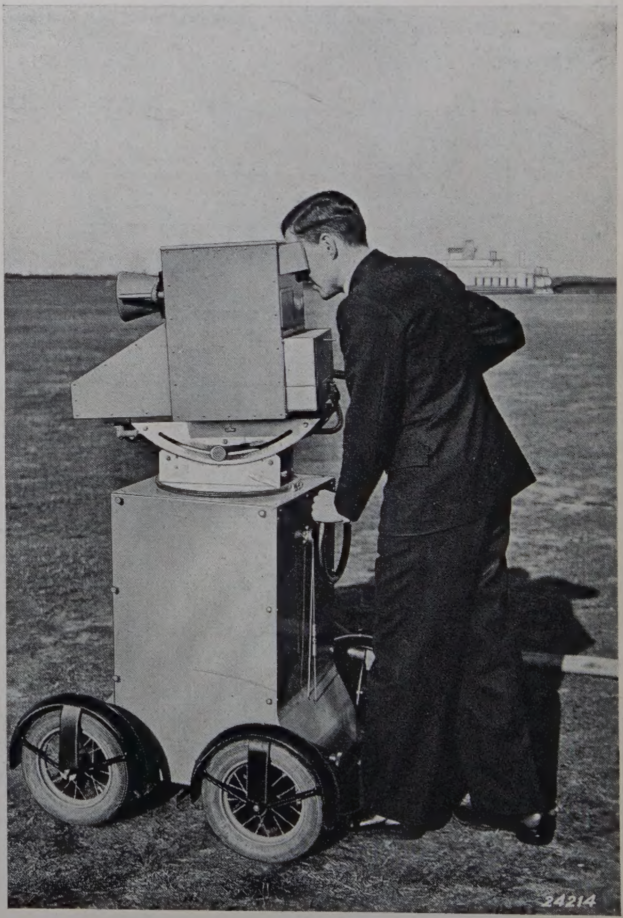

Fig. 4. The television camera in use.

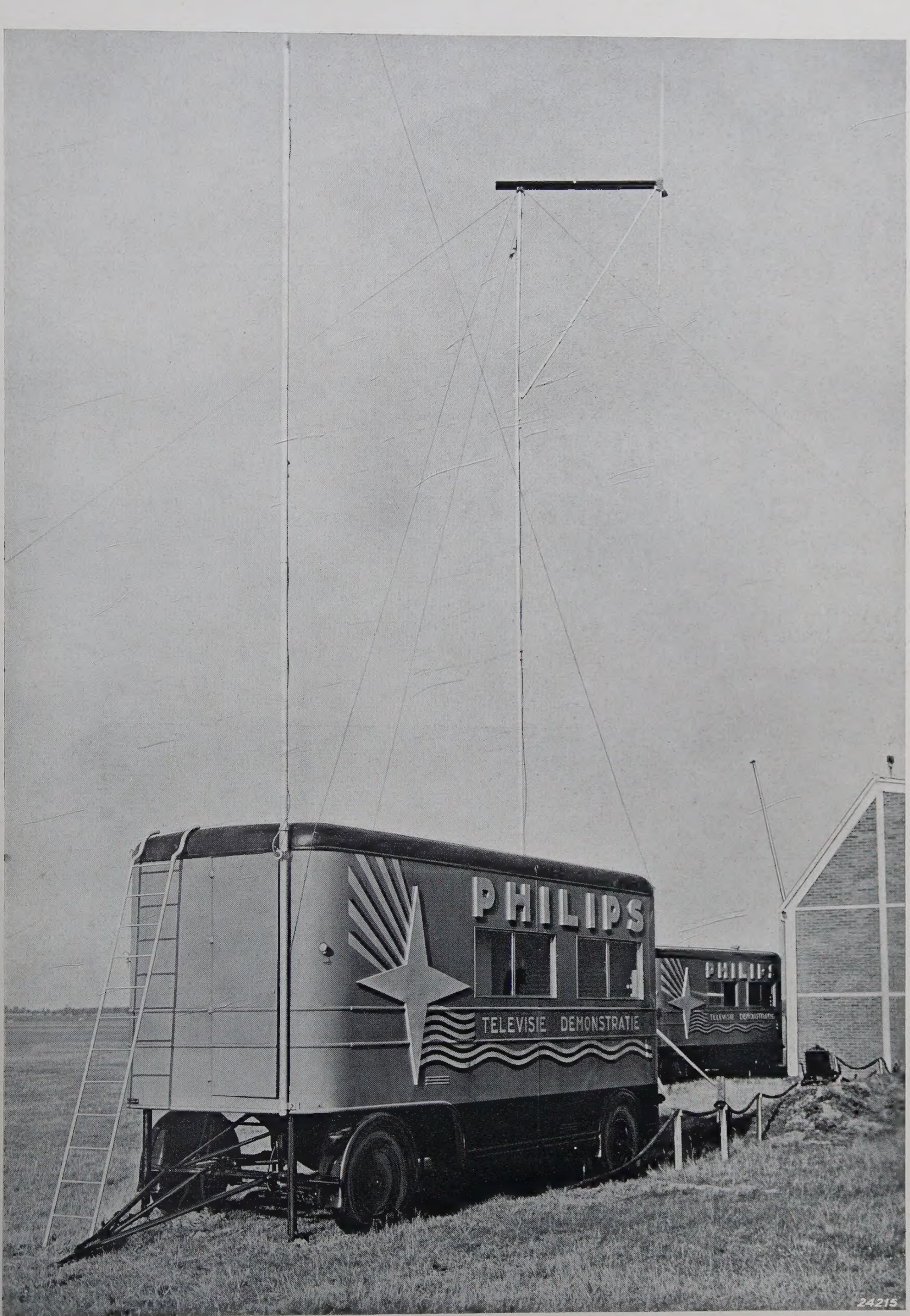

Fig. 5. In the foreground is the transmitter car with the two aluminium aerial masts set up. The aerial proper consists of a half-wave aerial fed at the middle, and is at a distance of a quarter wave length from the actual mast. In the background is the other car. The cable connecting the two cars is plainly visible.

the possibility of transmitting the picture by means of a cable directly to several demonstration receivers, in case local conditions make the use of a radio link impossible.

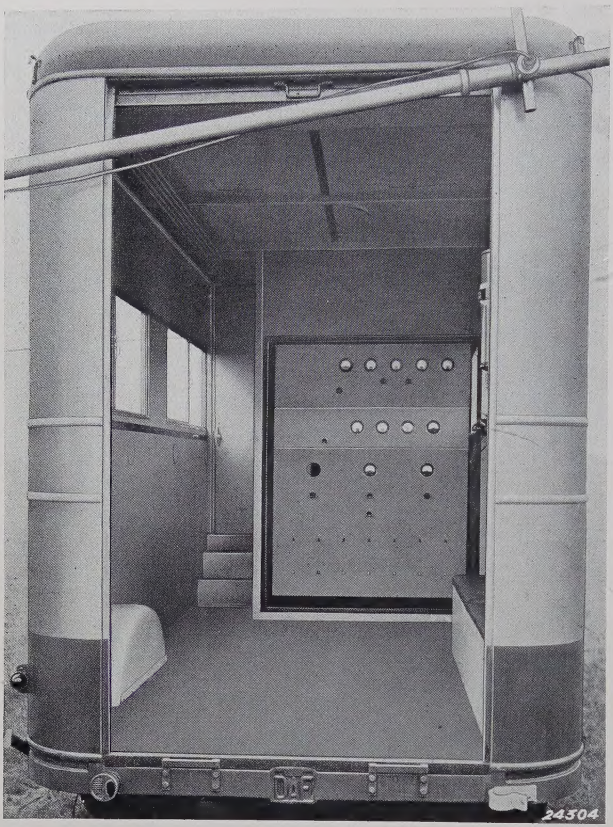

Fig. 6. View of the interior of the transmitter car with the picture transmitter. The sound transmitter is in another compartment of this car, reached by a door visible to the left of the picture transmitter. At the top of the photograph, in front of the shutter which closes the end of the car, may be seen part of the picture aerial demounted for transport. During transport the free space in this car is used for carrying the camera and the studio installation.

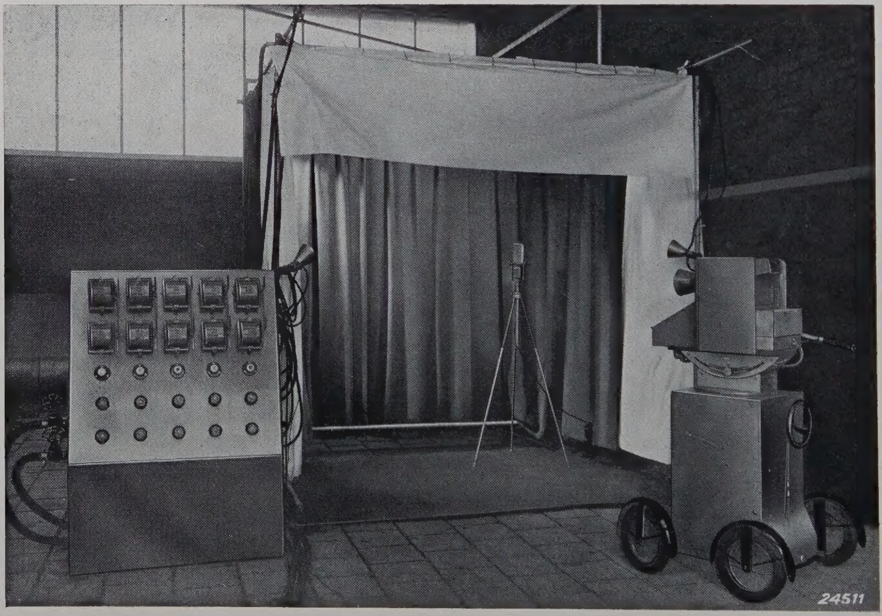

Fig. 7. The studio installation consists of an easily demountable framework of steel tubing, upon which, at any place, super high pressure mercury lamps may be fastened. This framework can be covered with cloth and forms in this way a small studio of a very simple type.
The cabinet contains the apparatus for the supply and operation of each lamp separately, and for the distribution of the cooling water for the lamps. The circulation and cooling of the water is effected by means of a small pump and a radiator.

THE USE OF ULTRAVIOLET RADIATION IN INDUSTRIAL LUMINESCENCE RESEARCH

by A. VAN WIJK.

544.63 : 621.327.31

In the case of many manufactured products abnormalities can easily be recognized by their luminescence. Because of this the observation of luminescence has provided valuable as a check in many industries such as the textile industry, the paper industry, the paint industry, the rubber industry, food industries and laundries. The ultra violet radiation of mercury lamps is used for exciting luminescence, the visible rays being absorbed by a filter. Two pieces of apparatus for luminescence analysis are described and several examples of their application are given.

Luminescence

The impression of colour which a mixed radiation makes on the eye depends upon the relative intensity of the wave lengths in the visible region occurring in that radiation. When a "white" mixed radiation falls on a substance, the reflected radiation may be coloured, that is, in the reflected light the relative distribution of the rays is modified in the visible region.

In many cases the observed change may be adequately explained by noting that each of the incident visible wave lengths is weakened in the reflection by a specific amount depending on the wave length and the substance, so that certain wave length regions make a relatively smaller contribution to the total light reflected.

The influence on the radiation by the substance irradiated is, however, not always confined to a more or less weakened reflection of each of the incident wave lengths individually. With an incident radiation of suitable wave length many substances have the property of emitting a portion of the absorbed energy with an altered, generally longer wave length ¹). If an appreciable length of time elapses between the absorption of energy and its radiation, one usually speaks of phosphorescence, otherwise of fluorescence. The two phenomena collectively are called luminescence. The phenomenon of luminescence may lead to differences between the mixed radiation incident on a substance and that reflected from it, which are essentially unlike the differences which occur in the absence of luminescence. When this property is present wave lengths may occur which are missing in the spectral composition of the incident radiation. The fact that colour changes due to luminescence are not usually observed in daily life, is not due to the fact that substances which exhibit the phenomenon are rare. On the contrary, a great number of substances in our surroundings have this property when they are irradiated with suitable wave lengths.

Nor does the cause of this failure in observation lie as a rule in the lack of these wave lengths in the light used for irradiation, but in the domination of light reflected normally, that is, without change in wave length. This is especially true when "white" light such as daylight or electric light is used. If the incident mixture of radiation is not white but coloured, the conditions for observation of colour components due to luminescence are more favourable, provided the luminescence gives wave lengths which are missing in the incident light.

Luminescence is, however, most striking when a mixture is used for irradiation which contains no visible light. Normal reflection then gives no visible component, so that there is no obstacle to the observation of any luminescence resulting from the irradiation with invisible rays. For the purpose of exciting luminescence in this way only radiation with a wave length shorter than that of visible light may be used, since the wave length increases upon luminescence. The first to be considered is, therefore, ultra violet light, which continues the spectrum at the short wave end of the visible region. Further the ability of X-rays to cause luminescence in substances is quite well known. Frequent use is made of this property in rendering X-rays visible, and in reinforcing the photographic action of X-rays ²). The use of X-rays for testing materials by luminescence, however, is out of the question for economic and other reasons (danger).

The character of the luminescence, that is the composition of the luminescence light, and

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¹) This law, called **Stokes'** law, is related to the fact that the energy of one light quantum is smaller at longer wave lengths. After losing a portion of its energy in reflection, a light quantum can change to a longer wave length, but not to a shorter one.

²) See Philips techn. Rev. **2**, 314, 1937.

even the very occurrence of the phenomenon upon irradiation with certain wave lengths, are specific properties of the substance irradiated, and as such are useful in the recognition and examination of that substance. In many cases the result of the method of manufacture or of a preliminary treatment manifests itself in the luminescence. The value of luminescence observation for material testing and process control is being recognized more and more in the most diverse cases in all kinds of industries.

Since the observation is very rapid and does not injure the substance examined or interfere with the process of manufacture, and furthermore since only very small quantities of the substance are necessary, while the results obtained in many cases are remarkably good, it is not surprising that luminescence analysis, as the process is now called, is steadily gaining ground.

Ultra violet sources of radiation

An important condition for the general application of luminescence analysis in industry is the existence of a simple apparatus, suitable for industrial purposes, which supplies a sufficiently intense ultra violet radiation with the exclusion of visible light. In the following we shall give a description of two such pieces of apparatus each of which has its particular range of application.

In both cases the necessary ultra violet light is supplied by quartz mercury lamps. The visible light emitted by these lamps is absorbed by a suitable filter. The filter is made of a special kind of glass "blackened" with nickel oxide.

Table I gives the transmission of two types of glass coloured with NiO for a number of mercury lines. In both cases the transmission for visible light is practically zero (except for the extreme red, where they both transmit again; since mercury lamps give only very little red radiation, this transmission of the red is usually of no great importance).

Table I.

Transmission of two types of "NiO"-glass. The objects tested were bulbs of equal thickness.

λ (Å) 1 Å = 0.1 mμ	Transmission in %	
	Type 1	Type 2
4047	2	2
3655	71	65
3342	68	27
3130	43	3
3022	28	—
2967	10	—

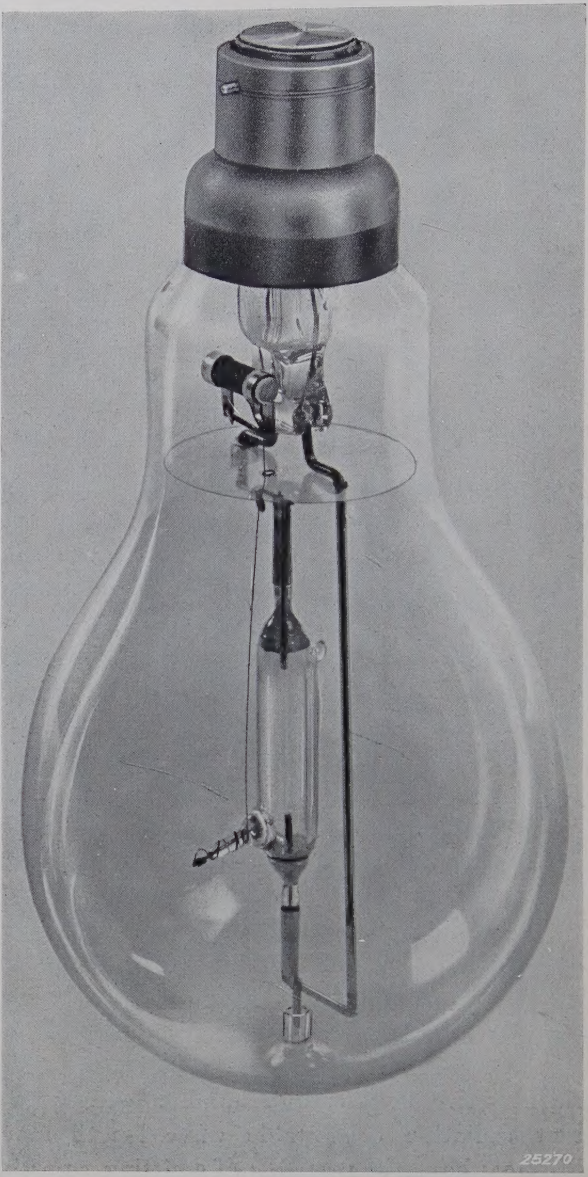

Fig. 1. The mercury lamp 80 watts, 3000 lumens.

The maximum of transmission for both kinds of glass lies at about 365 mμ, where the strongest line of the whole mercury spectrum is situated. On the other hand the two glasses show a great difference at shorter wave lengths. With type 1 the transmission of the wave lengths 313 mμ and 297 mμ is still considerable; with type 2 the transmission is here practically zero. This has been brought about by an extra addition to the molten glass in order to prevent the occurrence of conjunctivitis. Conjunctivitis (snow blindness) is a painful inflamation of the conjunctiva of the eye which can be caused by ultra violet radiation (mountain sunlight). All ultra violet light, however, is not equally active in causing this complaint; the shorter the wave length the greater the action [3]).

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[3]) See Philips techn. Rev. 2, 21, 1937.

Radiation with a wave length greater than about 313 $m\mu$ no longer causes conjunctivitis even in large doses; it is, however, effective in causing luminescence, so that without important sacrifices in the desired activity of the radiation, the safety of the user may be insured.

The most obvious method of obtaining a filtered beam is to build the lamp into a cabinet and to provide the cabinet with an opening which may be closed by a window of the filter glass. It is clear, however, that in this way only part of the radiation emitted by the lamp is available for use, unless the dimensions of the window are made very great. To this there are technical objections such as risk of cracking of the glass which has to be fairly thick. In the Philips apparatus a different method has been chosen which makes the total radiation of the lamp available by surrounding the lamp with an outer bulb of the filter glass.

As a source of ultra violet radiation the high pressure mercury lamp "Philora" 80 watt (*fig. 1*) and the "Biosol" lamp (*fig. 2*) are used. Both of these lamps have been described in this periodical 4). The high pressure mercury lamp of very small dimensions is always surrounded by an outer bulb. By making this bulb of the glass containing nickel oxide of type 2 above, a luminescence 80 watt lamp giving 3 000 lumens is obtained which may be connected directly to the 220 V alternating current mains *via* a small choke coil. By placing the lamp in a reflector made of material suitable for the desired application, the greatest possible efficiency can be obtained. Aluminium is a very suitable material for the reflector. *Table II* gives the intensity of the radiation emitted at a distance of 40 cm from the lamp in a direction perpendicular to the radiation element. The input to the lamp is 80 watts.

This lamp is suitable for use in cases where small samples are to be examined one at a time.

For industrial purposes where larger surfaces must be intensely irradiated it is better to use the "Biosol" lamp which gives a higher intensity and has a reflector specially designed to give a wide beam. The "Biosol"lamp, type A, is intended for use with a tubular filter which absorbs ultra violet radiation of wave lengths shorter than 280 $m\mu$. When the lamp is to be used for luminescence analysis this filter must be replaced by a similarly-shaped filter of NiO glass of type 2. The luminescence lamp so obtained is about 3 times as

Table II.

Intensity of the radiation of the HPW-80 Watt lamp at a distance of 40 cm in a direction perpendicular to the radiating element.

λ (Å) $1\ \text{Å} = 0.1\ m\mu$	Intensity in ergs/sec/cm^2
4047	13
3655	1050
3342	60
3130	32

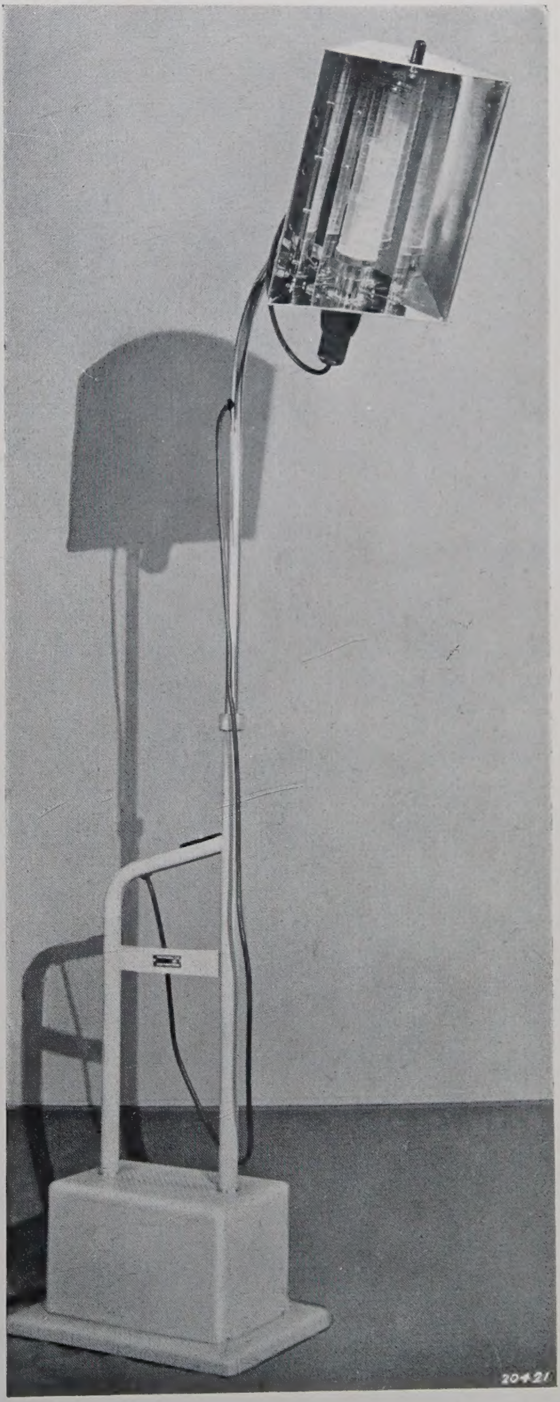

Fig. 2. Philips "Biosol" apparatus type A.

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4) The mercury lamp 80 watts, 3000 lumens, Philips techn. Rev. **1**, 129, 1936; the "Biosol" lamp, Philips techn. Rev. **2**, 18, 1937.

strong as the 80 watt lamp. The chromium-plated reflector increases the intensity in the working direction by an additional factor of about 2.5. At a distance of 50 cm the dimensions of the cross section of the beam are about $50 \cdot 80$ cm^2.

The higher intensity of the "Biosol" lamp necessitates a higher consumption of energy, namely 250 watts. The lamp HPW-125 occupies a position between the "Biosol" A with a NiO filter and the 80 watt lamp. This lamp is similar to the latter but it has an input of 125 watts.

Applications

Several examples of the application of these lamps are given in the following, from which it may be seen that the possibility of irradiating large areas is of practical importance.

Inspection of eggs: As was shown by van Oyen and Molanus the age of hens' eggs may be ascertained at a glance by means of the fluorescence of the shell. A fresh egg fluoresces red and an old egg blue. For checking large numbers of eggs, for instance at an egg market, luminescence analysis is the best method; it, is however, necessary that whole racks can be inspected at once.

Control of laundry: If hard water is used which contains lime, spots of insoluble calcium soap appear in the material. When these spots are fresh they are invisible under normal lighting conditions, while under the luminescence lamp they glow with a bluish brightness. For the inspection of large quantities of laundry the irradiation of large surfaces is desirable.

Invisible marking of linen: A clever application of the phenomenon of luminescence is the following. Instead of disfiguring numbers or other visible marks, the laundry stamps the incoming goods with a number in invisible ink of a kind which luminesces strongly. The ink is fast to washing, so that after being washed the goods may be sorted in the usual way by the light of a luminescence lamp.

Control of coloured textiles: Another interesting application of luminescence investigation is supplied by the textile industry. The printing of materials is often done with soluble colourless reduction products of dyes, the leuco-bases. Only in the following step, oxidation, is the insoluble adsorbed dye itself obtained. Printing faults can, in general, be seen only after the oxidation; they can then, however, no longer be corrected. Practically all the leuco-dyes fluoresce strongly upon irradiation with ultra violet light, so that the printed material may easily be inspected before the oxidation process with the help of the luminescence lamp. In this case also the observation of a large surface is desirable; in many cases, however, the simpler lamp is sufficient, since the luminescing power of the leuco-dyes may be very strong, and an extremely strong irradiation is then not required to make them visible.

It is impossible in the space of this article to give a description of the observations which can be made with apparatus for luminescence analysis on the diverse substances which enter into all kinds of industries. Such a description could not be given without reservations, moreover, because the observations are liable to be found incorrect in certain points upon closer examination. The extremely sensitive method of luminescence analysis has, in common with other sensitive methods, the property of being easily disturbed. In many cases the luminescing power of a given substance is due only to extremely small quantities of impurities, or such impurities may modify the luminescence. Sometimes such impurities will be essential for the use to which the substance is put, sometimes they are completely useless. In the latter case it would of course be incorrect to condemn the substance on the basis of the presence or absence of luminescence, or of luminescence of a changed character.

As examples of industries in which experience has shown the value of luminescence analysis in skilled hands, the following may be mentioned: textile industry, paper industry, paint industry, rubber industry, food industry, laundries.

In addition there is room for application in goods inspection, the detection of all kinds of falsifications as of checques, postage stamps, banknotes, paintings, etc.

It may be mentioned that in many cases the use of an extra filter between the eye of the observer and the substance being examined may prove valuable. This filter serves to absorb the ultra violet radiation reflected from the substance, as well perhaps as the mercury line with a wave length of 405 mμ which is transmitted by NiO glass.

It is incorrect to say that ultra violet radiation is entirely unobservable by the eye. Long ultra violet wave lengths give a certain impression, if the radiation is sufficiently intense. With respect to the limiting wave length there are individual differences, but the mercury line of 365 mμ used chiefly to excite luminescence is observable by practically everyone.

The light impression obtained upon looking directly into the luminescence lamp may be ascribed chiefly to the ultra violet radiation, with the exception of a small amount of red. By introducing a filter as described above, which absorbs radiation with a wave length shorter than about 410 mμ, but transmits longer wave lengths, a truer luminescence colour is observed. Many non-luminescing materials give the illusion of greyish blue luminescence without the filter. The filter can be best introduced directly before the eyes in the form of spectacles of a special glass. Noviol-O or Noviol-A glass of the Corning Glass Works is suitable for this purpose.

The luminescence apparatus may be employed not only for analysis but also for obtaining special lighting effects in shop windows or on the stage. In such cases, paints or textiles, of which there are many, are chosen for their strong luminescence.

Another important application of luminescence lamps may be in the making visible of objects (they may be painted with a luminescent paint) by means of a source of invisible light. For example in cases where there is danger of glare from sources of visible light, this application deserves serious consideration.

"PHILITE" AS A STRUCTURAL MATERIAL

by L. L. C. POLIS. 679.562

Several kinds of "Philite" are discussed with special emphasis upon their application in technology. In the first place their physical properties are described, and the conditions are discussed which must be fulfilled if the substance is to be used as a structural material, while finally various possibilities for the application of this material are indicated.

Introduction

In September 1936 a survey was given in this periodical [1]) of the most important kinds of "Philite", their properties and several possibilities of their application. Before this material can be put into practical use it must become as familiar to those using it as the materials which are now common, such as metals, wood, stone, cement, etc. For this purpose it is at first necessary that the different mechanical, electrical, chemical and thermal properties of "Philite" become generally known.

A table, accompanying this article, has been compiled in which the most important of these values are given. At the same time it may be seen from the table that very many different kinds of "Philite" are made, and that their physical and chemical properties are so widely divergent that it will usually not be difficult to find among all the different kinds a material which satisfies the requirements in any given case.

Since "Philite" must be pressed in a mould, it is possible to manufacture many kinds of articles in this way. If the shape of the article to be made cannot be pressed directly, or if it is one which would demand too great a complexity of the mould, "Philite" will be found to have the additional advantage of being easily worked.

Construction with "Philite"

Because of the high cost of the necessary mould, "Philite" is especially suitable for articles which have to be made in large numbers. Nevertheless, the financial returns on the mould, even from a small number of articles, rises with the increase in complexity of the product, that is with the increase in the cost of making the same product in another way, for example by machining or casting.

For complicated small articles (up to about 100 mm in diameter) (*fig. 1*) the manufacture of 500 pieces may be enough to make a mould pay for itself.

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[1]) R. Houwink, Properties and applications of artificial resin products, Philips techn. Rev. **1**, 257, 1936.

Kind of "Philite"	Tensile Strength	Resistance to Concussion	Resistance to Pressure	Modulus of Elasticity	Elongation	Surface and internal resistance in ohms (VDE) 1)		Resistance of 1 cm cube	Breakdown potential 2)	tan δ 4)	Dielectric constant 4)
	kg/cm²	kgcm/cm²	kg/cm²	kg/cm²	%	before tropical test	after tropical test	ohm cm/cm²	kV/mm	10⁻⁴	—
S	350	7	2000	80 000	0.5	10^{10}	10^{9}	app. 10^{9}	8	500	4 to
O	300	6,5	2000	80 000	0.4	10^{11}	10^{10}	app. 10^{10}	8	400	4 to
I	250	5.5	1200	130 000	0.2	10^{10}	10^{9}	app. 10^{9}	1 to 5	> 600	6 to
K	350	7	1800	78 000	0.4	10^{11}	10^{10}	app. 10^{10}	5 to 10	app. 600	4 to
P	250	6	—	40 000	0.5	$> 10^{12}$	$> 10^{12}$	10^{13} at 25°C	20 to 30	2 to 5	2.
160 D	300	5.5	—	60 000	0.5	10^{11}	10^{11}	10^{13} at 75°C	—	65	4 to
T	300	10	1500	78 000	0.4	10^{8}	—	—	—	> 600	4 to
Transphilite	300	5	—	60 000	0.5	10^{11}	10^{11}	10^{13} at 50°C	30 at 15°C 20 at 50°C	150	4 to
High tension "Philite"	300	6.5	2000	70 000	0.4	10^{11}	10^{10}	10^{13} at 50°C	30 at 15°C 20 at 50°C	app. 400	4 to
Philitext	750	50	2000	35 000 to 90 000	—	10^{9}	10^{6}	—	15 3)	> 500	4 to
Philitax	750	30	1500	60 000 to 100 000	—	10^{10}	10^{8}	—	25 3)	> 500	4 to
Planite	750	30	1500	30 000 to 100 000	—	10^{8}	10^{3}	—	app. 10	> 500	4 to

1) Measured according to V.D.E. specification 0302.

2) Alternating voltage peak value (not effective value).

3) For thicknesses greater than 5 mm this becomes 10 kV/mm.

4) Measured at a wavelength of 200 m, that is a frequency of 1.5 mega cycles per second.

5) Measured between 20 and 80°C.

	Linear coefficient of expansion 5)	Thermal Stability		Chemical resistance. All the kinds of "Philite" mentioned in this table are stable to weak acids, weak bases, alcohol, acetone and oil.						REMARKS	Kind of "Philite"
		Long exposure	Short exposure	Water	Strong acids	Strong alkali	Petrol	Benzine	Ether		
	10^{-6}	°C	°C								
5	40	130	200	yes8)	no	no	yes	yes	yes	Common "Philite"	S
5	40	130	200	yes8)	no	no	yes	yes	yes	Common "Philite", better electrical quality	O
5	20	215	220	yes	no	no	yes	yes	yes	Resistant to higher temperature and more resistant to moisture	I_2
	40	90	120	yes8)	no	no	yes	yes	yes	Suitable for light colours	K
4	100	606)	60	yes	yes	yes	no	no	no	High frequency "Philite"	P
5	—	215	220	yes	no	no	yes	yes	yes	High frequency "Philite", resistant to higher temperature	160 D
5	30	95	160	yes8)	no	no	yes	yes	yes	Quality with higher resistance to concussion (organic fibre filling)	T
5	60	200	220	yes	yes9)	no	yes	yes	yes	Transparent; also good electrical and chemical quality	Transphilite
5	40	130	200	yes8)	no	no	yes	yes	yes	Very high breakdown potential. Not suitable for outdoor use	High tension Philite
5	// layers 10 ⊥ " 80	95	150	yes8)	no	no	yes	yes	yes	Sheet material, for mechanical purposes only	Philitext
5	// layers 10 ⊥ " 90	130	150	yes8)	no	no	yes	yes	yes	Sheet material, for electrical uses only	Philitax
5	// layers 15 ⊥ " 50	125	125	yes8)	no	no	yes	yes	yes	Sheet material especially for mechanical purposes	Planite

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6) Softening point determined by Martens' method.

7) In some cases this value is only reached after heat treatment.

8) Upon long contact with water, the water is absorbed.

9) Not attacked by hydrochloric acid (sp. gr. 1.19) and phosphoric acid (sp. gr. 1.7) and at 100°C also resistant to a mixture of hydrogen fluoride and sulphuric acid (sp. gr. 1.22).

After the kind of "Philite" has been chosen on the basis of the data given here (cf. table), the shape must be determined with reference to the method of manufacture of the material. In the article quoted above, a diagram of a mould is given, from which may be seen the principle upon which the determination of the shape of the article rests.

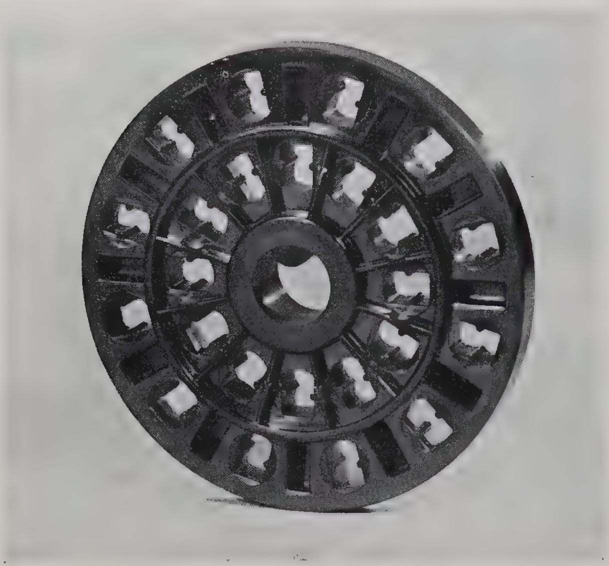

Fig. 1. Disc for switch shaft.

If it is desired to keep the mould and the process of manufacture as simple as possible, and thus as cheap as possible, care must be taken that the product is easily removable from the mould. Lateral projections or depressions are therefore excluded. On the other hand full use must be made of the valuable property of the material of temporary plasticity. Therefore supports, reinforcing and fastening knobs and ribs as well as parts for fastening such as nuts and bolts may be incorporated directly in the mould, so that they are pressed into the product without further expense.

This last-mentioned possibility, consistently exploited, is one of the most important advantages obtained from the use of the material. It means the elimination of loose clips for fastening, and the saving of time in assembling the apparatus of which the moulding is a part. *Figs 2*and *3* give good illustrations of this. In the example of fig. 2 advantage has also been taken of other properties of the material such as its attractive appearance, since this cover forms part of the body of a vacuum cleaner. Use is also made of the fact that the material is a good insulator, since the terminals which serve as connections for the current are pressed directly into the material. In this single example, therefore, advantage has been taken of the mechanical, aesthetic and electrical properties of the material. In *figs 4* and 5 parts of X-ray apparatus are shown in cross section as examples of the shapes which can be pressed from "Philite".

In the construction of articles from "Philite" there are several other points which demand attention. We shall discuss these points one at a time in the following.

The material does not become thin and fluid in the press but remains a tough plastic mass. The shape must therefore be chosen so that the mass need not flow around sharp angles, but so that the whole is stream-lined (*fig. 6*). Fig. 2 also gives a very good example of this. When this principle is not applied, unnecessarily high pressure must be used in pressing, and the risk remains that there will be incompletely filled spaces, called air spots.

Stresses occur in all products which are manufactured under a heat treatment. Since in the case of Philite these stresses cannot be removed by subsequent heating as is the case with glass, special consideration must be given in designing the form to provision for:

a) the greatest possible symmetry in the shape,

b) as near as possible equality in the thickness of the walls,

c) gradual transitions to thinner walls when local thickening cannot be avoided,

d) no sharp angles, and radii of curvature always as great as possible.

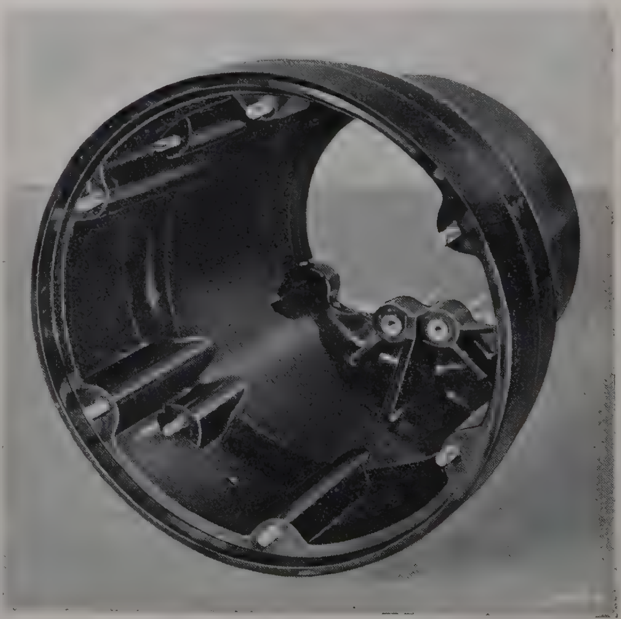

Fig. 2. Cover of a vacuum cleaner.

The mould must be divided in the correct way. It is very important that the cross section where the upper and lower moulds join should lie at the highest point of the article to be pressed, in order to prevent the enclosure of air which is no longer able to escape and therefore causes air spots in the moulding (*fig.* 7). The edge *A*, which forms a groove in the upper mould is filled with air. During the closing of the press this air must be forced through the press mass. Since this takes place at the very end of the process, that is, when the mould is practically closed, the press material has a greater tendency to escape through the opening between the two halves of the matrix than to fill the uppermost edge. The air is therefore unable to escape from this groove. In the construction of the mould provisions may be made against the escape of the material; these provisions however also hinder the escape of air. In the case illustrated the flange must be at the very top, or if an edge is necessary (fitting rim) it must be kept as short as possible (several millimetres at the most).

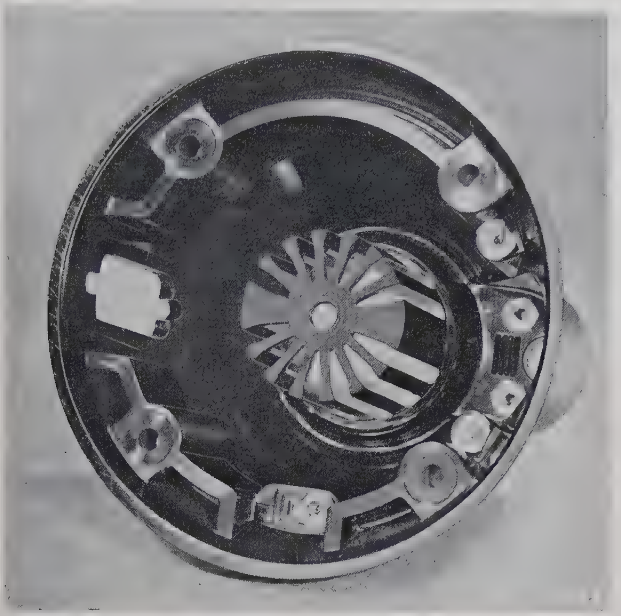

Fig. 3. Cover containing terminals of a vacuum cleaner.

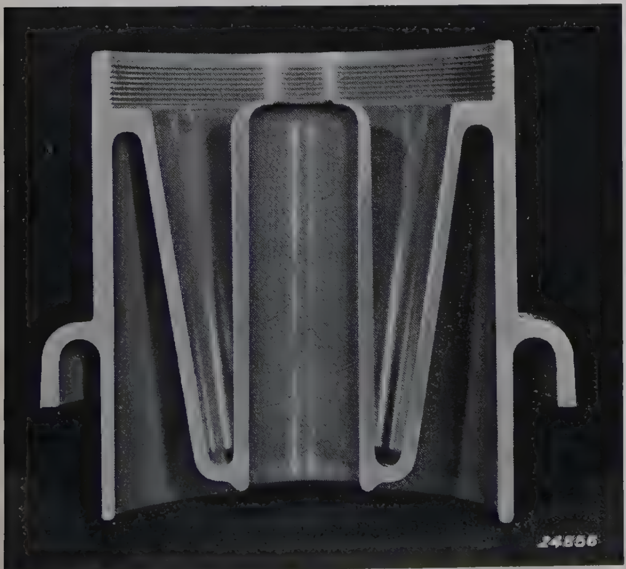

Fig. 4. Cross section of part of an X-ray apparatus.

"Philite" is a poor heat conductor, so that the thickness of the material has a very great influence on the time necessary for the material to harden in the heated mould. The material at the core must also be subjected to the high temperature for a sufficiently long time in order to complete the hardening process. This longer time for pressing is of course a factor in the cost price. Normal thicknesses of wall are from 3 to 6 mm; 10 mm must be considered as a maximum.

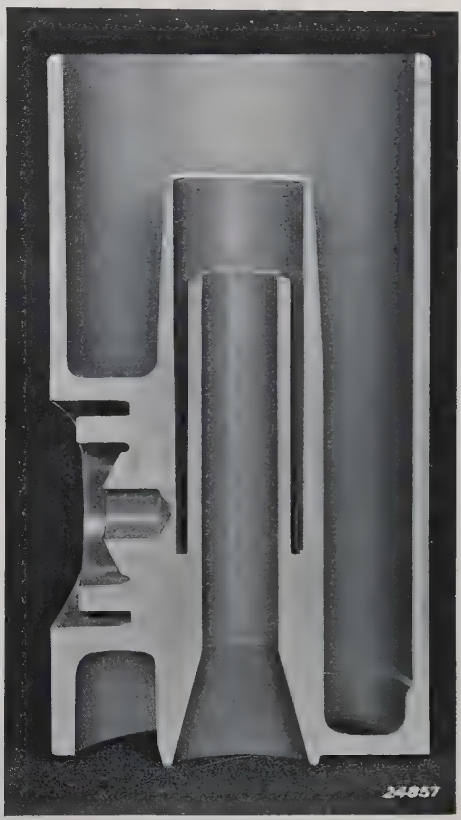

Fig. 5. Cross section of part of an X-ray apparatus.

Deep round holes with a small diameter, so that the depth is greater than twice the diameter of the hole, or any deep narrow holes must be avoided.

When one considers that a pressure of from 300 to 500 kg/cm^2 must be applied in the mould, it will be clear that the long thin projections of the mould which must form the holes in question would be subjected to enormous forces, and that bending or breaking might easily occur.

The metal parts for fastening, which are to be pressed in, may consist of eyelet-holes, bolts or nuts. There is little to be said about the first two; they must be provided with a head which is enclosed in the mass and which must be so constructed as to prevent turning and pulling out. The head is usually milled or made of hexagonal material to prevent turning, and is provided with a circular groove to prevent its being pulled out. A metal nut which is to be pressed in must be provided with the same guarantees against turning and pulling out. It is however also possible to press the screw thread directly into the "Philite", or as in metals to tap it afterwards. Although the pressed thread is better in quality than the tapped one, the pressing of the thread involves certain risks to the mould which one usually prefers to avoid by tapping. The shaping of the threaded hole must be done with the aid of loose pins which are extracted with the moulding, and then screwed out of the latter and reinserted into the mould. It may happen that these pins are not properly fixed in the mould, or, if they belong in the upper half, that they fall out, and seriously damage the expensive mould upon pressing. The method of tapping the thread will be used preferably when it is to serve for permanent fastening, for instance for the fastening of parts in a Philite radio cabinet.

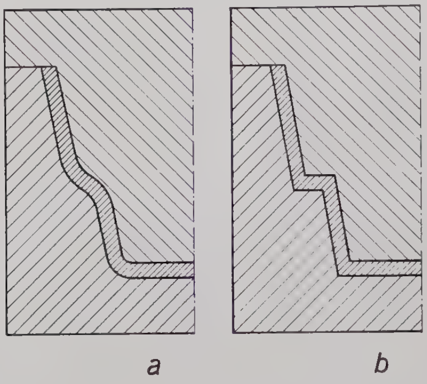

Fig. 6. Construction with "Philite" must be "flowing" as in *a*. No sharp edges as in *b*.

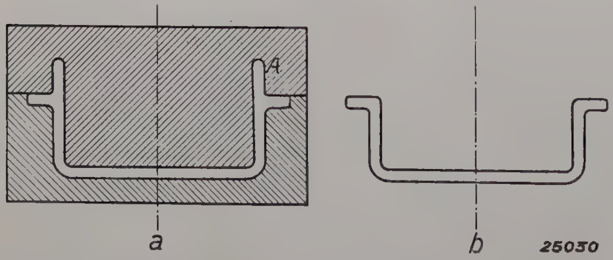

Fig. 7. The flange in *a* is incorrectly placed, so that the "Philite" has difficulty in filling rim *A*. The flange must be as high as possible as in *b*.

One condition for success is, moreover, that the length of the threaded part of the nut should be at least equal to twice the diameter of the bolt. Since the hole must be drilled before tapping, and the tap must have a few millimetres of play, and since also there must be sufficient material below the hole to prevent the drill breaking through (about 3 mm), care must be taken in the design that the projections in which the thread must be tapped are not too small (*fig. 8*).

Lateral projections or depressions can only be given to "Philite" mouldings at the cost of special provisions in the mould and in the method of pressing. Fig. 5 shows the cross section of a moulding with depression on one side. *Fig. 9* shows that spools or bobbins with several flanges can also be pressed from "Philite". The construction of these complicated forms must, however, be studied in each case individually, and can only be carried out with the closest cooperation of the mould maker. It necessitates a rather important increase in cost because of the more expensive mould and the longer time for pressing arising from the complicated manipulations between two successive pressings.

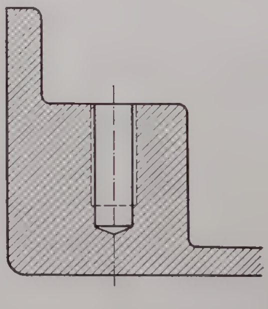

Fig. 8. Sketch of a tap hole in a "Philite" boss.

As has already been mentioned, because of the necessity of an expensive mould "Philite" is especially suitable for mass production. For this purpose it is advisable to try to make the design so that it consists of components which occur several times in the construction; and in addition to construct it in such a way that the same structural elements may be used for different purposes. Good examples of this are the switch shaft disc in fig. 1 and the condenser or insulator elements (*fig. 10*). The latter form structural elements of the Philips high tension apparatus as may be seen from *fig. 11*. Since they are provided at the top and bottom with a screw thread, they may simply be screwed together and form columns 6 to 7 m high, while by means of exchangeable parts in the mould these containers can be used as condenser pots, supporting and conduit insulators.

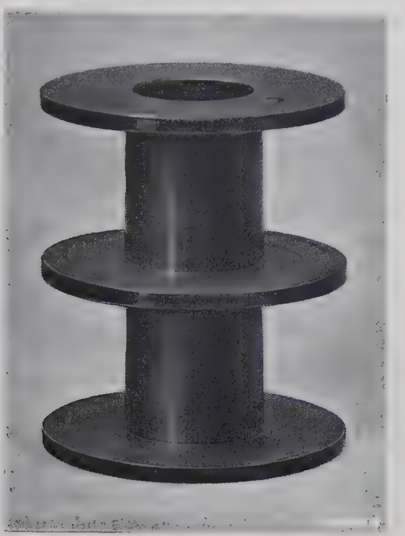

Fig. 9. Cylinder with three flanges.

Finally we shall discuss still another application of "Philite". Since the material ("Philite" T) has a coefficient of friction of only about 1/10 like good bearings metal with oil lubrication it is very suitable for the moulding of bushes. When we consider the fact that the maker of bushes has up to now worked exclusively with materials which were good heat conductors, it will be obvious that certain precautions must be taken in changing over to "Philite" having a poor heat conduction.

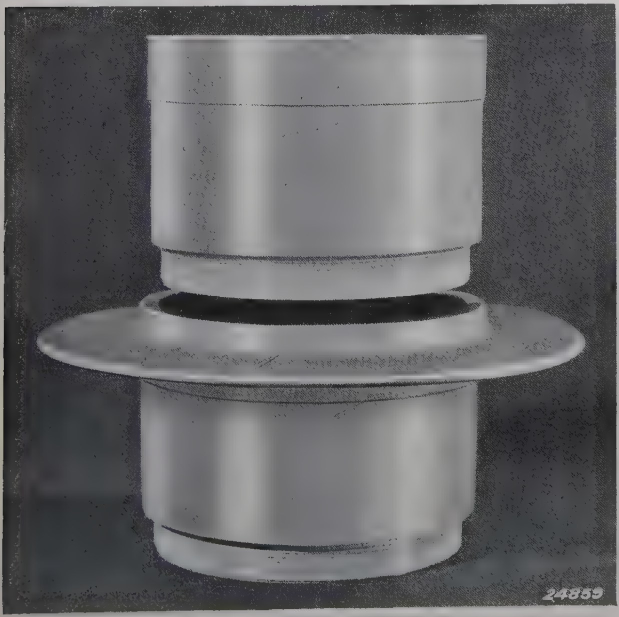

Fig. 10. Containers for condensers or insulators.

The first success with bushes made of artificial resins was achieved in the steel rolling mills in Germany, where they were used for slowly turning shafts with shaft pressures of 200 kg/cm^2. In connection with the poor heat conduction of the material, bushes of artifical resin must in the first place be provided with a good cooling system by circulation lubrication or with a special water-cooling system. A temperature higher than 80°C is not permissible in the bearing. Special attention is called to the possibility of lubricating these bearings with water, so that in their use in underwater motors and pumps a simplification of the construction is obtained. In view of corrosion and oxidation in the use of water it is, however, better to lubricate with oil or emulsions of oil and water. Furthermore it is desirable to make the bush in the form of a relatively thin shell of "Philite" enclosed in a metal housing, so that the heat can be more easily conducted away.

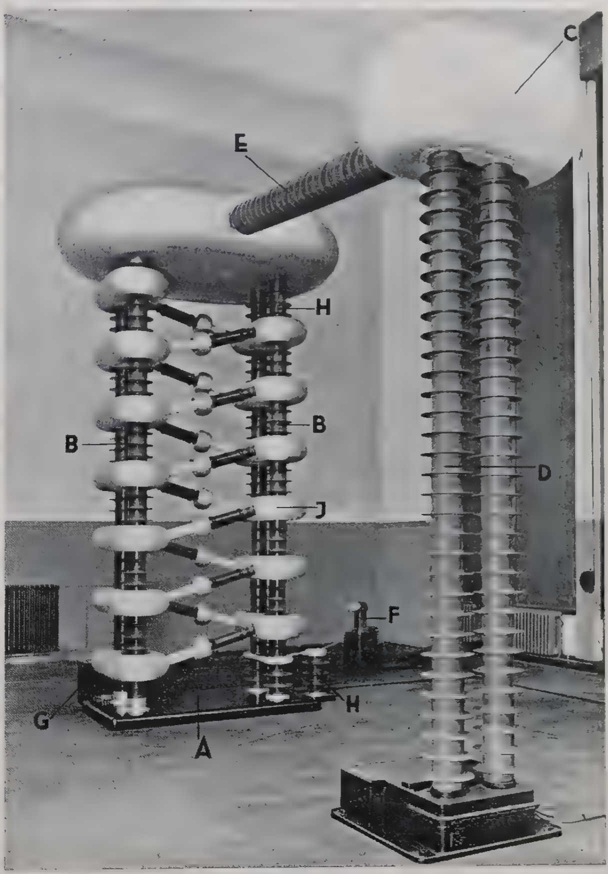

Fig. 11. View of high tension installation (described in Philips techn. Rev. 2, 161, 1937), in which the columns *B* and *D* are composed of the "Philite" elements shown in fig. 10.

With metal bearings a clearance of 0.2 per cent is usually allowed between axle and bearing, with bushes pressed from artificial resin a minimum of 0.25 per cent must be taken (in electric motors with small air gap), but where it is permissible the clearance should not be lower than 0.3 per cent.

The usual quantity used to characterize the load on the bush is the product pv of the specific pressure p in kg/cm^2 and the peripheral velocity v in m/sec. With normal lubrication with oil, water or an emulsion this product may be raised to 90 (p up to 40 kg/cm^2). With pressure lubrication it is possible to go as far as $pv = 250$ with the same maximum pressure.

A "Philite" bush will carbonize when it becomes too hot, and therefore the shaft bearing surface is not damaged. Since the shafts with the parts of the machine permanently attached to them often form an expensive part of the whole machine, this is an important advantage. On the other hand, however, the bushes of "Philite" must be more accurately centred than those made of metal. In the case of the latter it is possible for the metal to be forced out upon local overheating, so that a better centring is obtained and the bearings continue to run smoothly. In the case of bushes made of artificial resins, local combustion takes place under these circumstances.

Since products made of artificial resins have increased so rapidly in importance, the workmen who know how to handle this material have obtained their knowledge up to now only by practical experience, that is to say, in those industries in which the material plays such an important part as electrical insulation-material. From the foregoing it will be seen that the material may also be used extensively in other industries. Since, however, in these other industries experienced workmen are still lacking, the execution of the designs will in many cases have to be carried out by the manufacturer of the material. In order to reach the correct solution of a given problem it is necessary that the designer be fully informed about the function of the part in the machine or apparatus, and about all the influences to which it will be subjected. By giving adequate information to the designer disappointments may be avoided for which the material is often incorrectly held responsible. A study of the table will show that the properties of "Philite" are not unlimited, and that therefore its use does not mean the solution of every problem. A critical choice for a practical use is, as with all materials, essential; and when such choice has been made it will be found that with the proper use of the material many problems can be satisfactorily solved.

THE EXPERIMENTAL SHORT WAVE BROADCASTING STATION PCJ

by P. J. H. A. NORDLOHNE.

621.396.712.029.58

A description is given of the way in which the transmitter P.C.J. has been successively rebuilt for the purpose of increasing its output. Details are given of the recent enlargement of the transmitter. This station transmits at frequencies of 9.59 and 15.22 megacycles per sec, and gives an unmodulated carrier wave with an output of about 60 kW. Two triodes of type TA 20/250 are used in the final amplifier stage. There is a discussion of the difficulties which are encountered in the use of very high frequencies (above 2 megacycles per sec) due to the large size of these valves. In addition a description is given of the measures which can be taken to ensure that the valves behave the same in a short wave transmitter as in a long wave transmitter.

Introduction

In the beginning of 1937 the experimental short wave transmitter P.C.J. was again transferred from Eindhoven to the grounds of the Phohi (Philips Omroep Holland Indië) broadcasting station in Huizen. The transmitter was built in the Philips Laboratory in Eindhoven in 1926, and the first experimental transmissions on a wave length of about 31.5 m ($9.5 \cdot 10^6$ cycles per sec), which have since become historical, took place from that laboratory.

The original transmitter was controlled by a quartz crystal. The last stage contained a transmitter valve of the type TA 12/20 000 K; in this last stage the modulation was obtained by means of water-cooled modulator valves type MA 12/15 000. The aerial consisted at that time of a single wire 40 m long slanting upwards.

This transmitter was soon found to cause such interferences in the laboratory that it had to be moved. The choice then fell upon the factory grounds of the Nederlandsche Seintoestellenfabriek in Hilversum, where there was also room available for a more effective aerial installation. After several years of experimentation there, the broadcasting was temporarily stopped.

Meanwhile in Eindhoven a design had been developed of constructing a new transmitter with four water-cooled transmitter valves in the last stage. In addition the transmitter was to be made suitable for 15.22 and 9.59 megacycles per sec, that is, for both the available frequencies.

Furthermore sectional construction was to be employed. For the first stages, which, among other functions, must multiply the frequency of the quartz crystal, a transmitter was used which had been installed in the Carlton Hotel in Amsterdam from November 1930 to October 1931, and had served as an experimental broadcasting station on about 40 megacycles per sec [1]). This transmitter was supplied exclusively with alternating current, and could immediately be connected with 50 cycles supply mains. The transmitter could be rebuilt in a fairly simple way for the frequencies of 15.22 and 9.59 megacycles per sec, giving an output of about 1 kW. In this way the transmitter became the first section of the new transmitter P.C.J. Between this section and the final stage there had to be an intermediate stage with two smaller water-cooled valves (type TA 10/5000 K) where modulation was obtained. The new P.C.J transmitter with three. sections has broadcast experimental programs regularly since September 1934, at first only at 15.22 megacycles per sec, later at 9.59 megacycles also. It was set up about 6 km from Eindhoven on the railway line to Utrecht. The aerial consisted of a single horizontal dipole aerial which extended approximately in a North - South direction at about 22 m above the ground. Toward the end of 1936 it was decided to increase the output of the transmitter P.C.J. by adding a stage with two water-cooled valves of the type TA 20/250. These are valves each of which can give 60 kW carrier wave energy at the lower frequencies (less than about 3 megacycles per sec), with the possibility of 100 per cent modulation when used as class B amplifiers. At a frequency of 15.22 megacycles per sec about one half of this output could be counted on. This increase in output was to take place when the transmitter was transferred to the grounds of the Phohi transmitter in Huizen, where there was sufficient space available for setting up directional aerials, while many other improvements also were introduced.

Before passing on to the description of the enlarged transmitter we shall give a few particulars of the transmitter before it was enlarged.

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[1]) P. J. H. A. Nordlohne, Experimental Radio Broadcast on a Wave Length of 7.85 m in Amsterdam. T. Ned. Radio Genootsch. **6**, 1, 1932 (Dutch).

First section

This section contains a driver stage which is controlled by a piëzo crystal having socalled „zero temperature coefficient" cut and its frequency thus remains fairly constant without the necessity of a thermostat. The multiplication of the frequency takes place in several steps, followed by two amplifier stages. If the mains voltage were to change slightly this section would need considerable readjustment because it consists of 7 stages. This difficulty was avoided by the introduction of an induction regulator, so that the supply voltage of the whole section can be adjusted in one operation.

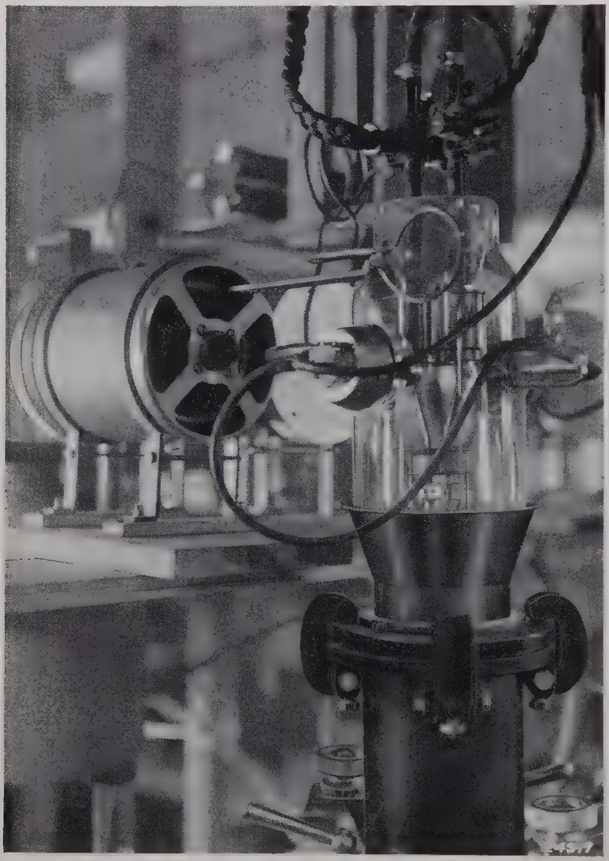

Fig. 1. The water-cooled output valve TA 20/250.

Second section

As already mentioned the second section contains the modulator stage. The grid and anode circuits are carefully shielded from each other. In order to avoid parasitic oscillations, the grid output terminals are connected directly with a pair of resistances, each of which is shunted by a coil of several turns. These coils form a high impedance for a possible high frequency parasitic oscillation but only a very low impedance at the frequencies used, viz. 15.22 and 9.59 megacycles per sec. By choosing suitable dimensions for the chokes between grid and filament, low parasitic frequencies are avoided.

The anode voltage to this stage is supplied by three gas-filled rectifier valves D.C.G. 5/2500.

Third section

The grid and anode parts are shielded from each other as much as possible in this stage also, and the whole section is very compactly constructed. Since the four triodes (TA 12/20 000 K) used in this section have an upper and a lower glass bulb, the mechanical layout of this section was obviously not very simple. The valves are inserted vertically in holes in a shielding plate with the grid below and the anode above, so that outside the valve the grid circuit is shielded from the anode circuit. The filament leads pass through the upper bulb and those of the grid through the lower one.

The constructional difficulty lies mainly in the fact that the valves must be able to be changed quickly. Moreover, there is the chance of undesired couplings due to the relatively strong stray fields of the neutralising condensers. In the P.C.J. transmitter therefore condensers are used which consist of a flat box, as the first electrode, containing a sliding plate which serves as second electrode. The whole is set up vertically in the grid compartment. The upper part of the box is at about the height of the horizontal shield. The box is connected with the grid of the neighbouring pair of valves, while the inner plate which is shielded by the box is connected with the anodes of the opposite pair of valves. This requires rather long connecting strips which are in the anode compartment.

Although no resistances are introduced into the grid and anode circuits, with this arrangement no parasitic frequencies occur over a wide range on both sides of the tuning point of the anode condenser and with aerial coupled. A resistance is introduced in parallel with the grid circuit, and forms the main load on the second section. It also provides that the excitation of the last stage has a linear relation to the depth of modulation, and is thus independent of the grid current load, which varies with the depth of modulation. With this arrangement of the third stage no extra measures are necessary to stabilize the valves.

The negative grid voltage is supplied by a special apparatus (R.S.A.) consisting of a six-phase rectifier with three rectifier valves, type No. 1768. This apparatus is heavily loaded in order to keep the voltage constant during modulation. The R.S.A. is provided with a liberally designed filter to prevent hum.

The anodes are fed by six gas-filled rectifier valves, type D.C.G. 10/15, which contain a grid and are connected in the ordinary six-phase circuit. By means of a three-phase induction regulator, whose stator and rotor windings are completely separated electrically, the phases of the grid voltages of this rectifier are regulated with respect to those of the anodes, so that the voltage can be varied very smoothly between zero and the desired value.

We shall now go on to describe the enlarged transmitter.

The 60 kW stage [2])

The first three sections of the P.C.J. transmitter can give about 12 kW carrier wave energy, which can be modulated for 100 per cent. The energy could of course be increased, as is sometimes done, by allowing several 12 kW transmitters to supply energy to the same aerial. The frequency is then determined by a single piëzo-electric crystal. Five such transmitters could in this way deliver about 60 kW. There would then be twenty triodes (12/20 000 K) in use, as well as many other triodes and diodes.

The more valves in use, the oftener "technical hitches" will occur, since every valve has a limited lifetime. Nevertheless the use of several similar transmitters in parallel may in some cases be justified. For an experimental transmitting station such as P.C.J., however, this parallel arrangement has no particular attractions. As an experiment it is interesting to find out whether this increased energy can be obtained with two triodes of higher power, on the one hand from the point of view of transmitting valve technique, and on the other hand from that of transmitter technique.

For this reason a fourth stage was added to P.C.J. which is provided with two triodes type TA 20/250 (*fig. 1*) which were developed for frequencies of about 3 megacycles per sec. The inter-electrode capacities have such a value that at a voltage of 15 kV and a frequency of 15 megacycles per sec the triodes became too hot, when in preliminary tests each lamp was allowed to develop continuously 100 kW in a self-oscillating circuit. The capacitive currents are then of the order of 100 A and raise the grid connections to red heat. In spite of watercooling all the temperatures were too high, including those of grid and filament supports. At an anode voltage of 15 kV and with 30 kW carrier wave energy per valve, the valves were found not to be overloaded providing that the above-mentioned water-cooling was introduced, and that the glass bulbs were shielded by a metal anode cap and metal grid caps. These caps prevent the occurrence of strong electric fields near the glass, and especially near the chrome-iron to glass joints.

For the use of the transmitter in a broadcasting station, experiments had to be carried out on stability and neutralising. Difficulties were expected because of the very steep slope of the characteristic of the valves and the high stray capacities with respect to earth, which tend to disturb the symmetry of the circuit. These difficulties were found to exist in practice. As a matter of course an attempt was made to build the transmitter as symmetrical as possible with respect to earth. The whole is built on a large copper ground plate, which may have the disadvantage of being a coupling element, but which also has the advantage of symmetry and constancy with respect to earth. Further the water for cooling the anode, as in the second and third sections, is supplied through the middle of the anode tuning coil, which consists here of a short Lecher system of two double copper tubes, two tubes for the ingoing water and the other tubes soldered to the first for the outgoing water (*fig. 2*). The rubber inlet and outlet tubes for the cooling water are thus attached at a point which is neutral with respect to high frequency, so that, provided they are set up at some distance, they have no influence whatsoever on the stability and the tuning. A sliding bridge provides for accurate tuning, while an extra coil between the two anodes serves for rough tuning. The anode voltage is also

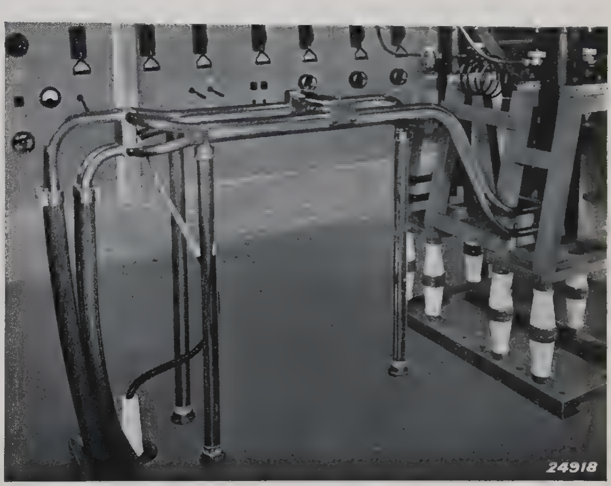

Fig. 2. Lecher system of two double copper tubes which also serve for the water-cooling.

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[2]) Various details of the circuit of the 60 kW stage and of the aerial system are due to K. Posthumus.

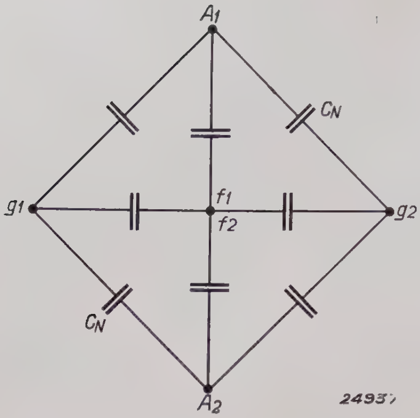

Fig. 3. Bridge circuit with only capacitive branches. A_1 and A_2 anodes, g_1 and g_2 grids, f_1 and f_2 filaments, C_N neutrodyne condensers.

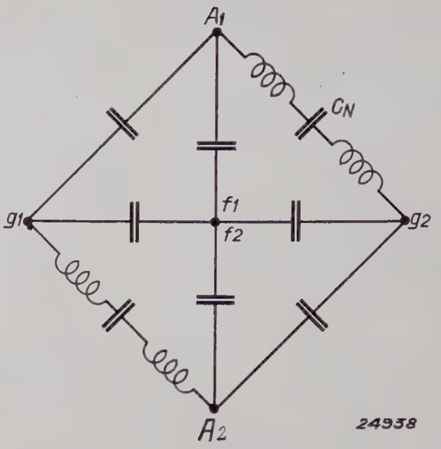

Fig. 4. Bridge circuit in which the equilibrium is disturbed by the presence of self-inductances.

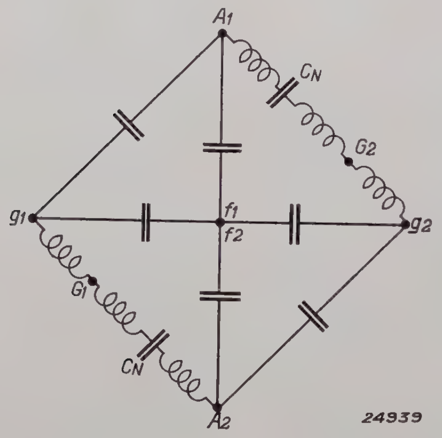

Fig. 5. Bridge circuit in which G_1 and G_2 represent the grid terminals.

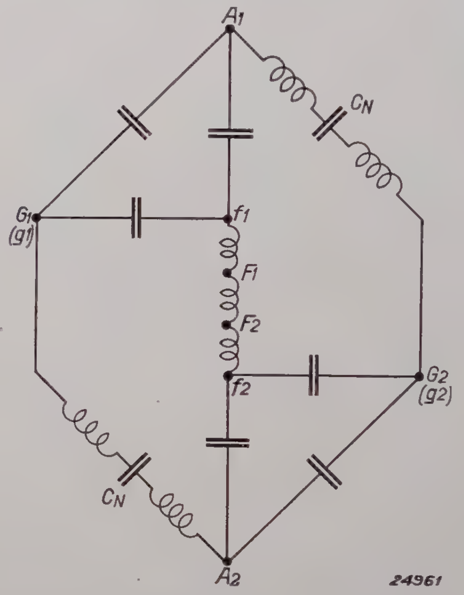

Fig. 6. Bridge circuit in which F_1 and F_2 represent the filament terminals.

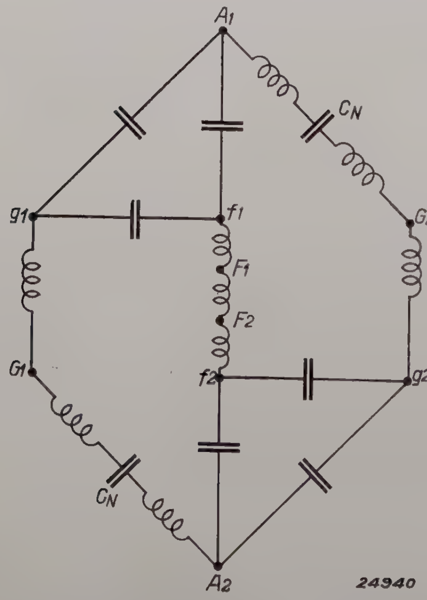

Fig. 7. Bridge circuit in which all possible disturbing self-inductances have been considered.

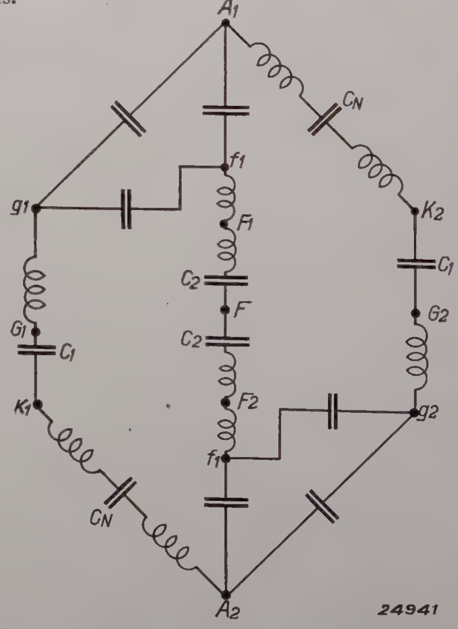

Fig. 8. Bridge circuit in which the filaments and grids are connected with the points F, K_1 and K_2 through condensers C_1 and C_2 which are tuned with the self-inductances of the connections.

supplied at the end of the closed Lecher system, which is the neutral point.

Two water-cooled loading resistances are introduced between the grids of the two valves. Each consists of a nickel iron wire which is wound non-inductively and is placed in a glass tube with inlet and outlet for water. The two resistances are in series, so that the connection between them carries no high frequency voltage. Nickel iron was chosen, because, due to its high permeability, there is a considerable skin-effect. Thus a high resistance can be obtained with a relatively short length of wire. In these resistances about 12 kW from the third stage is dissipated. For this third stage the resistances must form a much greater load than that caused by the variable grid currents of the fourth stage, so that a linear relation is as nearly as possible ensured between the high frequency voltage at the grids of the fourth stage and the depth of modulation.

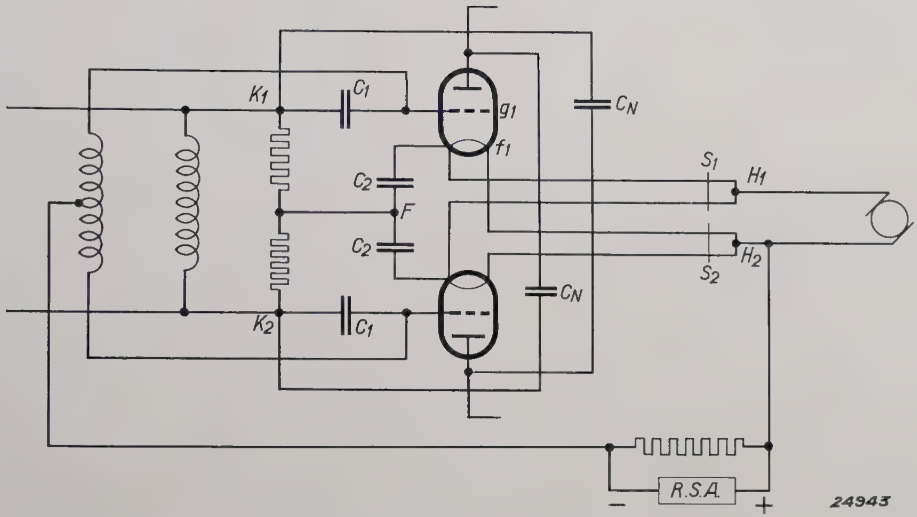

Fig. 9. Circuit diagram of two transmitting valves in parallel. H_1 and H_2 feeder terminals for the filaments f_1 and f_2. S_1 and S_2 adjustable bridges for tuning the Lecher systems. R.S.A. is the grid bias voltage apparatus.

On attempting to neutrodyne, the first difficulties appeared, and were connected with the use of triodes of such large dimensions with relatively high frequencies. Neutrodyning serves to keep the reaction small, that is, it serves as far as possible to prevent a high frequency current in the anode circuit of a valve from inducing an alternating voltage between grid and filament of the valve, or in the grid circuit connected with it. In general the second condition is fulfilled if the first is satisfied, because the grid circuit is connected directly with the grid and filament. In large transmitter valves and at very high frequencies, however, the inductive reactance of the connecting wires between the valve electrodes and the grid circuit may no longer be neglected, so that different voltages may prevail in the grid circuit from those between grid and filament. In order to demonstrate the solution of this difficulty we shall begin with the fundamental circuit diagram of the two transmitter valves given in *fig. 9*. We shall for the time being neglect the condensers C_1 and C_2 and we are then concerned with the substitute diagram of *fig. 3*. As soon as there are self-inductances in the branches of the neutrodyne condensers C_N, the equilibrium is disturbed (*fig. 4*), but can be reestablished with a different value of the neutrodyne condenser for one frequency. If, however, grid g and/or filament f are separated by self-inductances from their corresponding connecting terminals G and F, as is shown successively in *figs. 5, 6* and *7*, then by changing C_N it is impossible to prevent the appearance of potential difference between G_1 and F_1 (or G_2 and F_2) or between g_1 and f_1 (or g_2 and f_2) when alternating anode currents are flowing.

In order to meet this difficulty, condensers C_1 and C_2 are added in series with each of the two

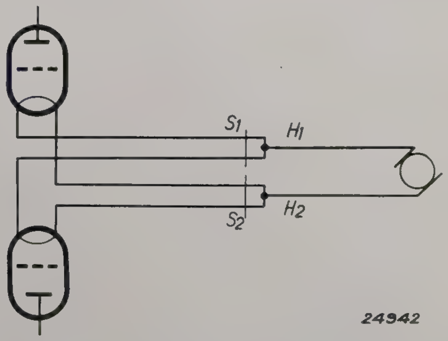

Fig. 10. Detail of the circuit diagram showing the filament supply.

grid connections and with each of the filament connections. These condensers are in series resonance with the self-inductances of the electrode connections for the frequency used (*fig. 8*) so that three points K_1, K_2 and F are thereby obtained outside the valves, which have the same high frequency voltage as the two grids and the filaments respectively. The two filaments are then at the same potential, i.e. at rest from the standpoint of high frequency, when the circuit is symmetrical, which can be brought about in a simple way using a two gang condenser.

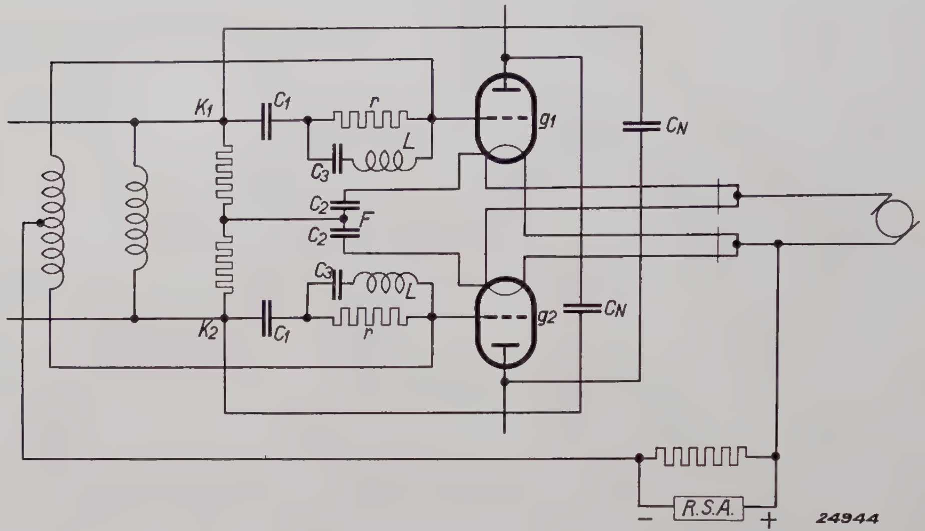

Fig. 11. Circuit diagram of the transmitting valves, in which self-inductances (L) and capacities (C_3), tuned to the working frequency, are introduced between grid (g_1 and g_2 respectively) and grid terminal (K_1 and K_2 respectively).

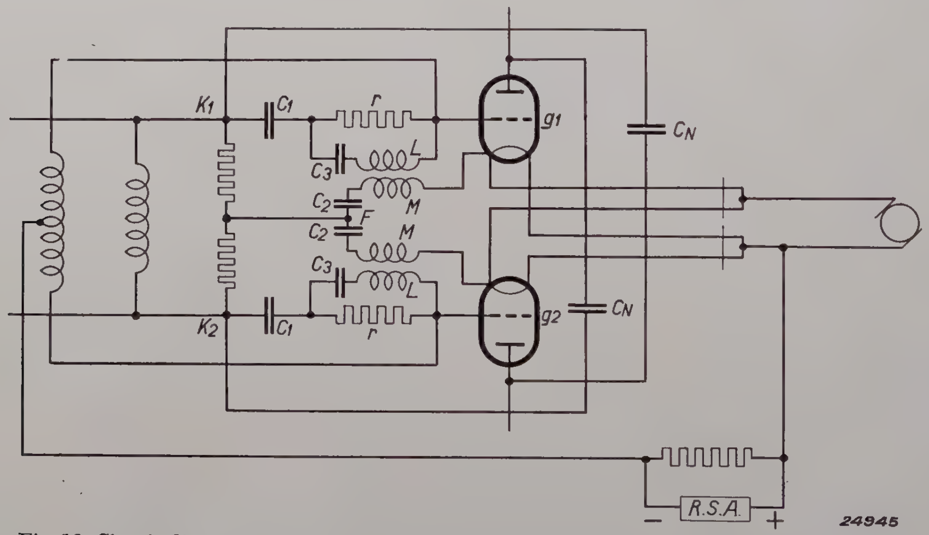

Fig. 12. Circuit diagram of the transmitting valves in which account is taken of the mutual induction M between filament and grid.

For a single frequency, therefore, fig. 8 can be replaced by fig. 4. At this frequency the circuit shows no reaction.

All other connections are now made at the points K_1, K_2 and F thus established: grid tuning coil, neutrodyne condensers, loading resistances and high frequency grid feeders (from the third stage, cf. *fig. 9*).

Since the filament connection terminals F_1 and F_2 are at high-frequency voltage, the source of current for the filaments cannot be connected directly to these points, but the filaments must be fed through two Lecher systems, which are tuned to a quarter wave length by means of S_1 and S_2 (*fig. 10*) and therefore form an infinite impedance for the frequency in question. The tuning by S_1 and S_2 is not critical. It is enough if the filaments are joined to each other by means of a constant high impedance. H_1 and H_2 are neutral points at which the machine for feeding the filaments may be connected without difficulties.

One of the points H_1 and H_2 is connected to earth and also with the positive terminal of the grid bias apparatus. The negative terminal is connected with the grid terminal through two chokes of copper or resistance wire.

In spite of the fact that a very good neutrodyning is now obtained, it must be kept in mind that stability is assured only for the working frequency. There is no guarantee that parasitic oscillations of very high or fairly low frequencies will not occur, or an oscillation of a frequency in the neighbourhood of the working frequency. Both kinds of parasitic frequencies are suppressed by a resistance r connected directly in series with the grid terminals (*fig. 11*). Such a resistance, however, is also a resistance for the working frequency, and would therefore have to pass the high capacitive currents, as soon as excitation occurred. An air-cooled resistance could, therefore, not be considered. Moreover, such a resistance would absorb excitation voltage. This is prevented by introducing a series circuit consisting of a condenser C_3 with a self-inductance L in parallel with the resistance, which circuit is in resonance with the working frequency. This circuit has a very slight damping, so that even with only a slight difference in frequency it has a higher impedance than the resistance which is in parallel with it. It is actually found that the stage is now quite stable, even with no load on the anode circuit. The above-mentioned series circuit is of course not so sharp that the modulation bands are passed through with decreased intensity; on the other hand, however, the neutrodyning is sufficient guarantee of stability for such small differences in frequency (of the order of 0.07 % at the most) and even for larger differences.

Since the long filament connection is strongly coupled with the grid connection which runs parallel to and at a short distance from it in each of the valves, there is a high mutual induction between anode and grid circuit, so that an undesired back-coupling occurs, and the output cannot be increased. This difficulty is met by compensating these undesired mutual inductions by the introduction of opposite mutual inductions outside the valves (M in *fig. 12*). In the beginning there were still difficulties with the grid and filament series condensers C_1 and C_2 which form the leads of the grids and filaments. These condensers have relatively low capacity and allow high capacitive currents to pass, so that the voltage across the condensers becomes very high with danger of flashover. By giving them proper proportions and especially by rounding off the edges and making the surfaces absolutely smooth, these difficulties were also finally overcome.

The use of two such large triodes for a high frequency means a long step ahead on the road to increasing-output, as was explained in the introduction to this article. There is now nothing to prevent the construction of a broadcasting transmitter for ultra short waves for several hundred kilowatts carrier wave energy. This may be done by combining several 50 to 75 kW transmitters of the above-described type.

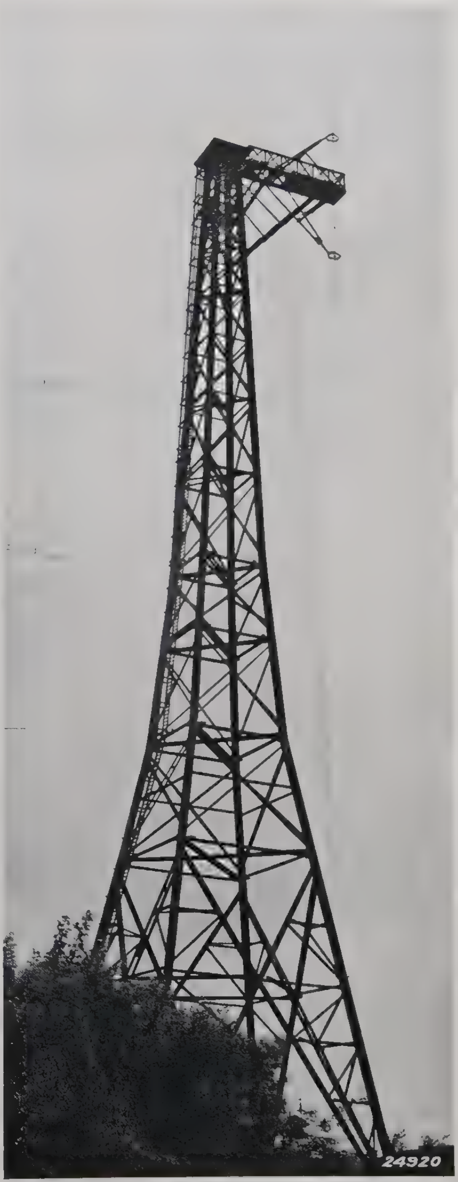

Fig. 13. Wooden mast with platform to which a vertical dipole aerial is fastened.

Aerials

When the transmitter was still set up in the neighbourhood of Eindhoven, experiments were made with a horizontal dipole aerial hung between two masts only about 25 m high. Upon transfer to Huizen an aerial for a wave length of 19.71 m was put into use, which was directed towards the Dutch East Indies, as well as a vertical dipole aerial which was suitable for 19.71 and 31.28 m (15.22 and 9.59 megacycles per sec respectively).

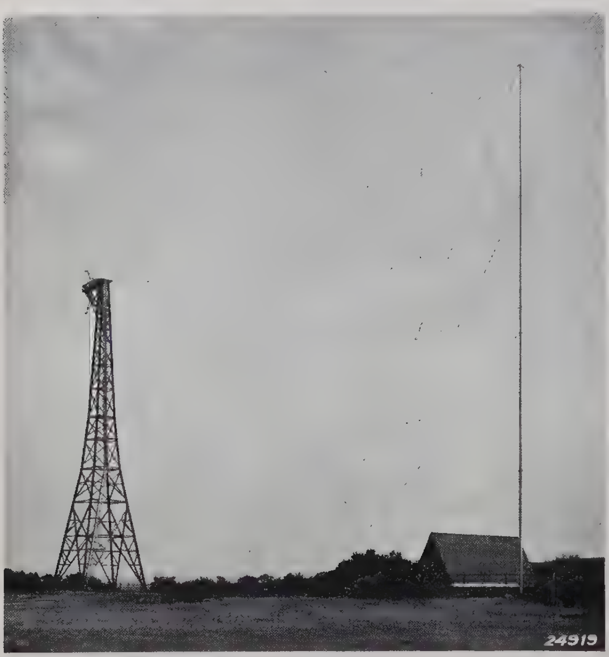

Fig. 14. Directional aerial set up on the grounds of the Phohi transmitter in Huizen.

The directional aerial was hung between a wooden tower and a steel Mannesmann mast, both 60 m in height. A tower was chosen in connection with the available space; a wooden tower was chosen because the vertical dipole aerial was to be fastened to it, and a steel tower would cause too many losses. In connection with supporting lines and feeders it was necessary to fasten the dipole aerial several metres away from the tower. This made it necessary to build a platform on top of the tower, as well as two arms which slant upwards and downwards respectively, and serve to hold the two ends of the dipole aerial by means of an insulated construction (*fig. 13*). This fastening of the dipole could not be done at a voltage node, because in that case the free end of the rod would be too long in connection with wind pressure and the like. Moreover, the voltage node does not fall in the same place for both the wave lengths to be used. The rods are thus held at a point where some high-frequency voltage is present, so that proper insulation became necessary. The rod is now held between three supporting insulators which lie in a horizontal plane. The insulators are mounted on a heavy brass ring. The two rods are thus firmly fixed and can be fairly easily connected with the feeders which are brought up outside the tower, go through the floor of the platform and then run horizontally to the dipole aerial.

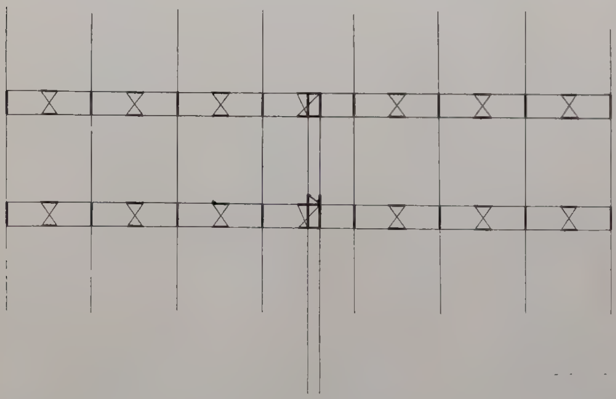

Fig. 15. Circuit diagram for the feeding of the directional aerial.

The length of the dipole aerial is chosen so that for a wave length of 31.28 m each of the rods is almost a quarter wave in length and therefore for a wave length of 19.71 m each is about $^3/_4$ of a wave in length.

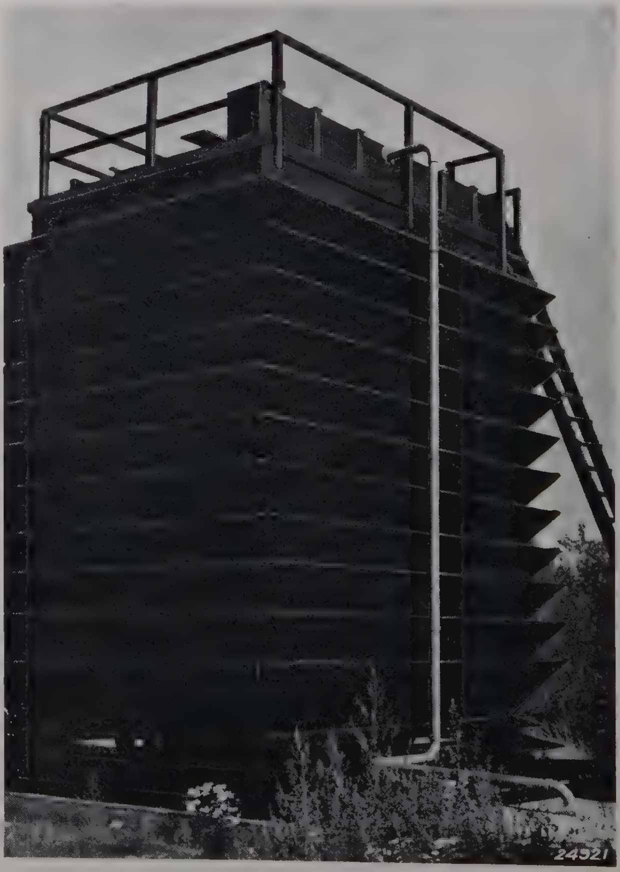

Fig. 16. Scrubbing tower for the water cooling.

The length of the dipole is not critical, if only care is taken that half its length is not more than half the length of the shortest wave to be used, since otherwise opposing currents will be present in the aerial. Since the half dipoles used in the P.C.J. transmitter are about 7.43 m long, they form for the 19.71 m wave a set of two dipole aerials one above the other, while for 31.28 m they form a single dipole.

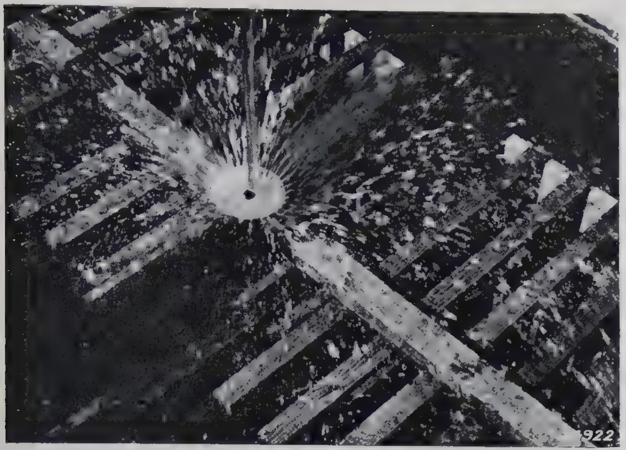

Fig. 17. The cooling water splashes against the wooden latticework of the cooling tower.

The aerial directed toward the Dutch East Indies is for a wave length of 19.71 m and, as has already been mentioned, is hung between the wooden tower and a 60 m high guyed Mannesmann tube (*fig. 14*).

The directional aerial itself consists of 24 vertical half-wave aerials: three rows of eight (*fig. 15*). The feeders connected with these aerials run mainly horizontal and feed successively all the aerials at voltage loops of the feeders. Apart from slight losses in the feeder lines themselves, all the aerials are connected with points of equal potential, while the equality of phase is also insured, independent of mutual coupling of the aerials by radiation. The influence of the insulators had previously been studied and also of cross points in the aerial structure on the potential along the horizontal feeders, and it was found that the various lengths must be carefully measured.

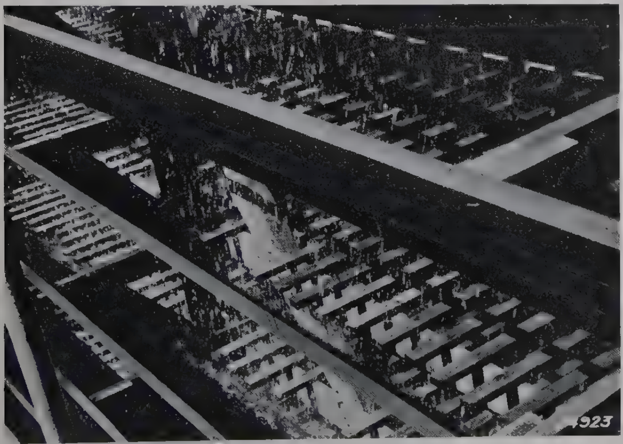

Fig. 18. The cooling water runs through the tower in a finely-divided state.

Cooling system

With an efficiency of 30 per cent in the triodes of the type TA 20/250, and with an output of about 30 kW per valve, one must count on about 70 kW anode dissipation per triode, and therefore the anode cooling water must remove 140 kW. In addition there is the anode dissipation of the four triodes type TA 12/20 000 K, and of the two triodes of the type TA 10/5 000 K, and finally the heat developed by the water-cooled resistances, so that the total energy to be removed by the cooling water can be estimated at about 190 kW. A temperature of about 18° C is suitable for the ingoing cooling water. With this temperature there is no trouble with condensation on the lines even in the summer, while with about 240 litres/min for the two triodes type TA 20/250 the temperature of the outgoing water remains far below the highest permissible temperature at which the formation of boiler-scale and similar disturbing phenomena begin to appear. It must be kept in mind, that the highest temperature of the water in the cooling jacket is much higher before the mixing; in the determination on 120 litres/min this is taken into account in the manufacture of the jackets. The remaining smaller water-cooled triodes, as well as the water-cooled resistances, require about 70 litres/min, so that one arrives at a pump capacity of about 300 litres/min.

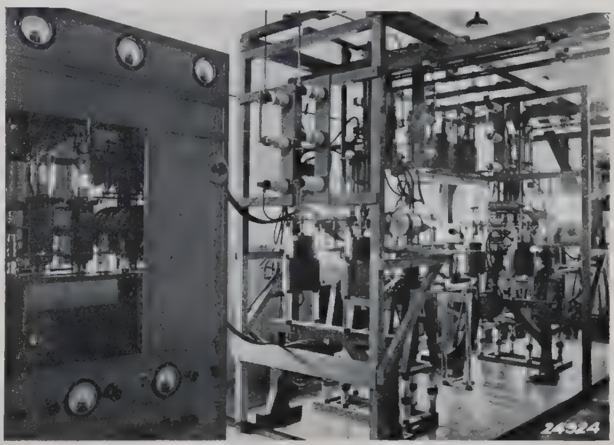

Fig. 19. Third section and end stages for wave lengths of 19.71 and 31.28 m.

In order to bring the water which has been heated in the valves back to room temperature, it is allowed to flow through a cooling tower (*fig. 16*). The cooling-water is pumped out of a concrete tank containing 44 cubic metres through the cooling jackets of the triodes and returns again to the tank. To prevent a continual rise in the temperature of the water in the tank, another pump raises the water which then falls on a lattice work and is thus divided into drops (*figs. 17* and *18*). In this way an excellent adjustable cooling is obtained. In such a simple system water of course evaporates. This loss is supplied from a well which gives iron- and calcium-free water.

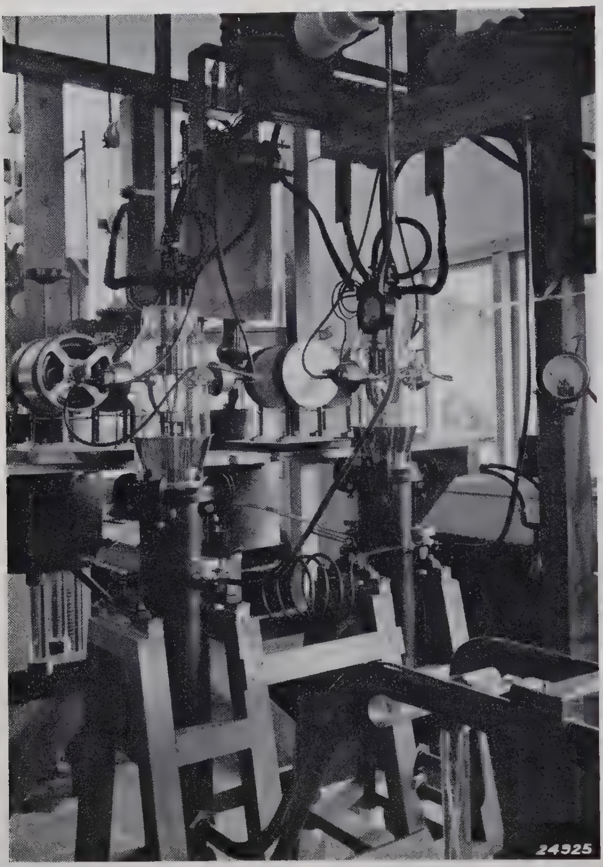

Fig. 20. Closer view of end stage for a wave length of 19.71 m.

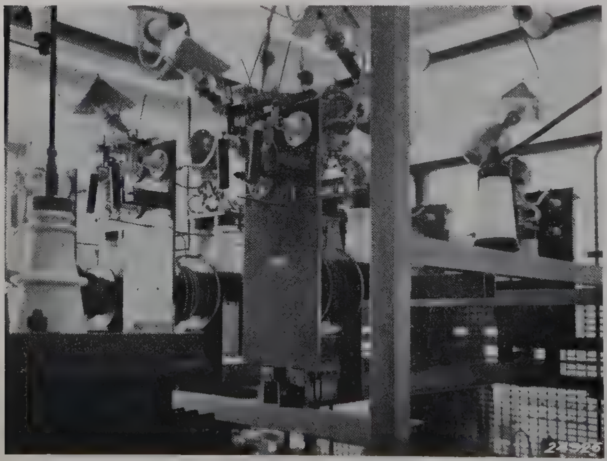

Fig. 21. The rectifiers D.C.G. 10/15 which feed the third section.

Several photographs at the end of this article give an impression of the third section, and of the two final stages for wave lengths of 19.71 and 31.28 m (*fig. 19*). In *fig. 20* may be seen details of the stage for 19.71 m which is still in the experimental state. In this figure the short water-cooled Lecher system with sliding bridge may be seen, as well as the triode TA 20/250, the series condensers C_1, C_2 and C_3 and the coupling M of fig. 12. *Fig. 21* shows the rectifiers D.C.G. 10/15 which feed the third section, while *fig. 22* shows the rectifier installation for the 60 kW stage. The rectifier valves D.C.G. 5/30 are not visible but are

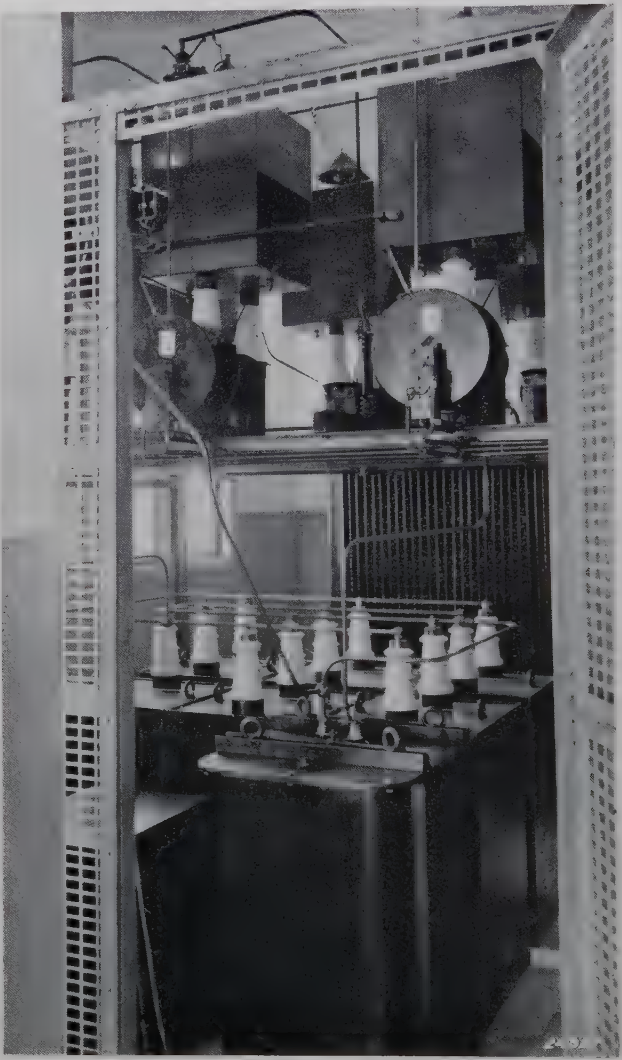

Fig. 22. The rectifier installation for the 60 kW stages.

situated in the open metal boxes in the upper part of the figure. Below each of these boxes the filament current and starting transformer for the diode above may be seen. On the floor are standing the condensers and choke which form the filter, while in the background part of the high tension transformer is visible.

In the case of the transmitter for 31.28 m which has recently been put into service, use is made of a new kind of directional aerial, whose direction can be varied. A description of this aerial must, however, be given in a later article.

THE UNIVERSAL DECIMAL CLASSIFICATION *)

by L. C. J. TE BOEKHORST.

025.45

A librarian must be able to give a reliable answer when asked what literature is present on a given subject. Besides the subject catalogue of the works present in the library, he refers to the different reference indices and encounters the difficulty that they all make use of different systems of classification. It is therefore not to be wondered at that there has been for some time an effort to unify the various systems of classification.

In 1876 the American librarian Melvil Dewey ¹) published a classification of all sciences according to a decimal system. This system was revised in Europe by the Institut International de Bibliographie in 1895, elaborated and introduced as the "Classification Décimale Universelle". It has been more and more widely used in recent years, and is continually being extended by the International Committee for Universal Classification of the Institut International de Documentation (I.I.D.) which has its seat at the Hague.

Various short treatises ²) have been published by the I.I.D. itself or with its approval, besides the complete editions which have already appeared or are still in the process of being published ³).

The decimal classification divides the whole domain of human knowledge into 10 main classes, each of the main classes into 10 other classes, and each of these into not more than 10 sub-classes, etc.

The main classes are the following:

0	generalities, bibliography, documentation
1	philosophy, psychology
2	religion
3	social sciences
4	philology
5	pure sciences
6	applied sciences
7	art, games, sport
8	literature
9	geography, history, biography

Main class 6, applied sciences, is divided as follows:

60	general considerations
61	medical sciences
62	engineering
63	agriculture and dairying
64	domestic economy, housekeeping
65	commerce, business organization, communications, transport organization, accountancy, industrial organization
66	chemical technology
67	various industries and manufactures
68	various trades, industries and professions
69	building construction

Class 62, engineering, is subdivided as follows:

620	general considerations
621	general mechanics and electrical engineering
622	mining
623	military and naval engineering
624	civil engineering (general)
625	road and railroad engineering
626	hydraulic engineering
627	engineering in natural waters: rivers, lakes, sea
628	sanitary engineering
629	traffic engineering

Class 621, general mechanics and electrical engineering, is divided in the following way:

621.0	general mechanical theory
621.1	production and use of steam
621.2	utilization and distribution of water power

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*) Editor's note. Since we have decided to give the articles a decimal classification number from now on, it seemed appropriate to give in this issue a short description of the internationally accepted decimal classification system which will be used.

¹) Melvil Dewey: A classification and subject index for cataloguing and arranging books and pamphlets of a library — 1876.

²) Universal decimal classification. Abridged Netherlands edition —1934 — I.I.D. Publ. No. 194.

³) La classification décimale universelle. Edition compléte — 1927 - 1929 — I.I.D. Publ. No. 151.

621.3	electrical engineering
621.4	internal combustion engines and heat engines other than steam
621.5	pneumatic energy
621.6	blowing and pumping machinery
621.7	factories and workshops, foundries
621.8	transmission machinery
621.9	machine tools, hand tools and workshop practice.

For highly specialized subjects numbers with many figures are obtained in this way. For clarity a decimal point is placed between every 3 figures. As an example of the complete specification of a subject the following may serve:

5	pure sciences
53	physics, mechanics
535	light, radiation, optics
535.3	reflection, refraction, absorption, emission
535.33	spectra, emission spectra
535.338	form of spectra
535.338.3	line spectra
535.338.33	structure of line spectra
535.338.332	fine structure of line spectra

In practice the sub-division does not always go as far as possible; the larger the number of publications present on a given subject, the farther the sub-division.

Here and there in the system numbers are left unused in order to be able to give a logical place to a possible new subject. At the same time the scheme also offers the possibility of further subdivision whenever this proves necessary.

It will often happen that the contents of a publication cannot be represented by a single main number. If a work treats of two independent subjects, for example chemistry, class 53, and physics, class 54, the two corresponding classification numbers are joined by the sign +:

53 + 54 textbook of physics and chemistry.

In the case of a work on "material testing in iron and steel manufacture", in which the two different subjects:

620.1	material testing and
669.1	iron, steel

are joined, the two classification numbers are combined by means of a colon:

620.1 : 669.1 material testing in iron and steel manufacture.

The following are examples of such combinations of classification numbers. To characterize an article on "a double current welding apparatus" we obtain the following index:

621.791.735 : 621.314, in which

621.791.735	indicates a welding apparatus with electric arc, and
621.314	means conversion of electric current.

An article on "The electron microscope as an aid in metallographic investigation is dismembered as follows:

537.553.72	electron microscopy
621.385.833	electron optical tubes
669.016	metallography, and indicated by

537.533.72 : 621.385.833 : 669.016.

In addition to the main classes indicated by one of the numbers from 0 to 9 and their subdivisions already discussed, the decimal classification, also has auxiliary classes which further define the main concepts and are indicated by certain signs. There are special and general auxiliary classes.

The special auxiliary numbers are used to define more precisely the subjects of a whole group in a particular sense. They may only be used in this sense with that definite class. They are separated from the preceding numbers by a point and always begin with zero.

Special auxiliary numbers in class 621.3, electrical engineering, are for instance:

.027	kind of tension
.027.2	low tension
.029	kind of frequency
.029.5	high frequency
.029.58	short waves

With the following main class numbers from class 621.3:

621.318.4	electric coils
621.396.11	propagation of radio waves in the atmosphere and above the earth's surface, we can therefore make the following combinations:

621.318.4.029.5	high frequency coils
621.369.11.029.58	propagation of short radio waves.

An article on "protection of overhead low tension mains against overvoltage" may be given the following classification number:

621.316.1.027.1 : 621.316.9

In this number 621.316.1 indicates distribution mains and .027.2 low tension, while 621.316.9 represents protection.

An article on "the recording of rapidly occurring electrical phenomena with the aid of cathode-ray tube and camera" receives the following classification number: 61.317.087 : 621.385.832 : 771.3, in which 621.317 indicates electrical measuring technique, and the auxiliary number .087 indicates recording. The numbers 621.385.832 and 771.3 indicate respectively cathode-ray tube and camera.

The general auxiliary numbers may be used with any main concept. The most important are those for "form", "place" and "point of view".

Auxiliary numbers for form, represented by (0):

(021)	handbooks
(05)	periodicals

Combinations:

621.396 (021)	handbook of radio technique
621.396 (05)	radio periodical

Auxiliary numbers for place, represented by ( ):

(492)	The Netherlands
(73)	The United States

Combinations:

621.311 (492)	electrical power stations in the Netherlands
654.19 (73)	radio broadcasting in the United States

Auxiliary numbers indicating point of view, beginning with .00:

.001.5	scientific and technical research
.003.2	financial point of view

Combinations:

62.001.5	technical research
654.19.003.2 (492)	the financial condition of the the Netherlands radio broadcasting.

Auxiliary numbers are only used when the main numbers do not indicate a concept sufficiently clearly.

In the arrangement of the single decimal classification numbers, for instance in a catalogue, one must imagine that from each number a decimal fraction is formed by setting a 0 in front of it. The various numbers are then arranged according to the increasing values of these decimal fractions.

ABSTRACTS OF RECENT SCIENTIFIC PUBLICATIONS OF THE N.V. PHILIPS' GLOEILAMPENFABRIEKEN

1224: W. Elenbaas: Der Gradient der Hochdruckentladung in verschiedenen Metalldämpfen (Physica **4**, 747 - 751, Aug. 1937).

The gradient in the high pressure discharge in cadmium and zinc vapour is measured in volts per cm as a function of the tube diameter; the amount of metal vapour per cm of arc and the energy consumption per cm are also measured. These are compared with earlier measurements on high pressure mercury tubes. With the vapours of the three metals named it is found possible to describe the gradient by means of the same formula, in which only the constants vary for the three vapours. The relations between these constants for the different gases correspond to expectations.

1225: J. A. M. van Liempt und W. van Wijk: Die Schnell-analyse des Edelgasgehaltes in Stickstoff (Rec. Trav. chim. Pays Bas **56**, 755 - 759, July 1937).

The method described in **1191** for the analysis of mixtures of argon and nitrogen by absorption of the latter in liquid lithium is further elaborated for mixtures rich in nitrogen, so that at present the content of rare gases in nitrogen can be determined in 3 minutes.

1226: A. Bouwers: Les radiographies instantanées. (Arch. Él. méd. **45**, 89 - 93, Mar.-Apr. 1937).

This article begins with the setting up of the socalled regularity condition (cf. **1124**), according to which the sharpest X-ray photographs are obtained when the kinematic lack of sharpness, the screen lack of sharpness and the geometrical lack of sharpness are equal. Conclusions are drawn from this for use in exposure technique, while finally it is stated that apparatus with a condenser which discharges itself over a self induction is very suitable for instantaneous X-ray photographs.

1227*: M. J. O. Strutt: Sound distribution over existing heavy current electrical mains. (Gedenkb. Prof. Feldmann, Waltman, Delft, 1937, pp 355 - 362).

A system is developed with which four sound programs can be distributed over existing electric mains from a central transmitter to all those connected with the mains, by means of four carrier waves of 20 000, 30 000, 40 000 and 50 000 cycles per sec. From measurements of the characteristics of low voltage mains, high voltage mains, telephone cables and special measuring arteries in this frequency range, the technical and economical possibility of this distribution system has been established. On the basis of these measurements the necessary energy for given mains can be calculated. The technical construction of the system is described briefly.

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*) An adequate number of reprints for the purpose of distribution is not available of those publications marked with an asterisk. Reprints of other publications may be obtained on application to the Natuurkundig Laboratorium, N.V. Philips' Gloeilampenfabrieken, Eindhoven (Holland), Kastanjelaan.

1228: J. van der Mark: Television with the aid of the iconoscope (Hand. 26e Ned. Natuur- & Geneesk. Congr. 63 - 68, 1937).

For the contents of this lecture the reader is referred to Philips techn. Rev. **1,** 16 and 325 (1936).

1229: C. Dorsman: Television with the aid the Nipkow disc and multiplier (Hand. 26e Ned. Natuur- & Geneesk. Congres, 68 - 73, 1937).

For this lecture see Philips techn. Rev. **2,** 72 (1937).

1230: W. G. Burgers: The electron microscope in metallographic investigation (Hand. 26e Ned. Natuur- & Geneesk. Congr. 124 - 127, 1937).

The material discussed in this lecture is given in detail in Philips techn. Rev. **1,** 313 and 321 (1936).

1231: Balth. van der Pol: Concerning an infinite number of coupled oscillation circuits in connection with the problem of the cable (Hand. 26e Ned. Natuur- en Geneesk. Congr. 145 - 148, 1937).

It is explained how the transition can be made from an infinite number of coupled oscillation circuits to a continuous cable; cf. the detailed article in Philips techn. Rev. **1,** 367 (1936).

1232: J. L. Snoek: Magnetic Investigation of structure by means of patterns in iron filings (Hand. 26e Ned. Natuur- & Geneesk. Congr. 157 - 159, 1937).

The patterns produced in iron filings are studied in the case of anisotropic rolled nickel iron band for pupin coils in which the elementary magnets in the plane of the band lie perpendicular to the direction of rolling. On the side surface where the magnetic field is perpendicular to the surface, figures appear in the filings which upon commutation of the field pass over into their complementary figures. On the surface of the band not only regular parallel stripes, but also peculiar branches occur, which are difficult to reconcile with the hypothesis that the iron-filings patterns occur at the edges of the elementary magnetic zones.

1233: C. J. Dippel: A very sensitive quartz spiral spring balance (Hand. 26e Ned. Natuur- & Geneesk. Congr. 167 - 169, 1937).

The apparatus described in Philips techn. Rev. **1,** 126 (1936) is discussed in this lecture. It is possible to weigh down to a microgram in a vacuum with this apparatus.

1234: N. W. H. Addink: The relative positions of emission and absorption bands in fluorescence (Hand. 26e Natuur- & Geneesk. Congr. 171 - 172, 1937).

In the case of the fluorescing dye rhodamine, the lowest frequency absorbed is lower than the highest frequency emitted, so that the absorption and emission bands overlap. The absorption is found to be independent of the state of excitation of the rhodamine. The emission band is much extended toward lower frequencies with an increase in the temperature from —75°C to +20°C, while it changes little at the higher frequency side. Such an influence of temperature cannot be explained by means of the theory proposed in 1928 by Perrin for fluorescence, but follows logically from a consideration of potential curves.

1235: A. Bouwers: New possibilities for radiotherapy (Hand. 26e Ned. Natuur- & Geneesk. Congr. 251 - 257, 1937).

In this lecture given before the medical section of the congress a survey was given of modern research on the transmutation of atomic nuclei (cf Philips techn. Rev. **2,** 97, (1937)). The possibility is discussed of the application of induced radio activity in therapeutics.

1236: W. J. Oosterkamp: The quality of X-ray films (Ned. T. Geneesk. **81,** 2805, June 1937).

This article is a briefer edition of the article reviewed in **1214.**

1237: A. Bouwers: Die Schärfe des bewegten Röntgenbildes (Fortschr. Röntgenstr. **56,** 148 - 149, July 1937).

Ordinary X-ray photographs are sharpest when the geometrical lack of sharpness, kinematic lack of sharpness and screen lack of sharpness are equal, because their product determines the amount of light available. With the rapid successive exposures used in cinematography, however this is not so, since the energy supplied by the tube increases more slowly than proportional to the width of the focal spot. In taking X-ray films therefore it is well to take the geometrical lack of sharpness smaller than the kinematic and screen lack of sharpness. The periods of rest between the exposures may be taken about three times as long as the time of exposure. When projection is used, 90 per cent of the light is lost even when very fast objectives are used so that ten times as much light is needed. The total lack of sharpness therefore becomes about twice ($\sqrt[3]{10}$) as great in the most favourable case.

1238: J. van Niekerk: Anaphylaxis and Vitamin C (J. Allergy, **8,** 446 - 449, July 1937).

The influence of vitamin C on anaphylactic sensibilisation and shock was studied in experiments with Guinea-pigs. Horse serum was used as an anaphylactogen, the sodium salt of 1-ascorbic acid as vitamin C solution. It was found that an avitaminosis C, a scorbutic condition, of the experimental animals had no influence on creating an anaphylactic sensitivity or on the shock phenomena caused by a second injection in sensitised animals.

In the amounts used of 25 to 100 mg and administered in the manners described, vitamin C has no protective action against the usually fatal shock symptoms in consequence of the second injection of the anaphylactogen. Addition of vitamin C to horse serum does not hamper the anaphylactogenic action of the latter.

1239: B. D. H. Tellegen and V. Cohen Henriquez: Inverse Feedback (Wirel. Eng. **14,** 409 - 413, Aug. 1937).

After an introduction giving the general characteristics of inverse feedback (cf. Philips techn. Rev. **2,** 289, 1937), its application to amplifiers for sound reproduction is discussed. A two-valve amplifier is described which feeds a loudspeaker and is provided with inverse feedback of the voltage on the loudspeaker to the cathode of the first valve with a dependence on frequency such that the desired frequency characteristic is obtained.

Measurements of frequency characteristics and distortion show the advantages of inverse feedback.

1240: A. Bouwers und A. Kuntke: Ein Generator für drei Millionen Volt Gleichspannung (Zs. techn. Phys. **18,** 209 - 219, Aug. 1937).

A critical survey is given of the different methods used for generating the very high voltages such as are necessary in nuclear physics (cf Philips techn. Rev. **2,** 97, 1937). The cascade generator is described (cf Philips techn. Rev. **2,** 161, 1937). The pulsation of the voltage and the fall in voltage upon loading are calculated. The high voltage is measured with the help of an oil-cooled measuring resistance, through which a maximum current of 1 mA flows. The high voltage is then read from a static voltmeter which is connected with one one-thousandth of this resistance. The high voltage is regulated by means of the energizing field of the alternating current generator. Experience with 1.6 MV direct voltage with respect to earth is discussed, as well as measurements with a spark gap between spheres 1 m in diameter, up to 1.3 MV with respect to earth. It must be especially noted that after long functioning the occurrence of a flash-over across unexpectedly long distances seems to be unavoidable.

1241: D. M. Duinker: Siebkreise für Gleichrichter (Elektrotechn. u. Masch.-Bau **55,** 381 - 388, Aug. 1937).

The filter used with a rectifier is for the purpose of smoothing the pulsating direct voltage. In designing the filters account must be taken of the highest permissible currents which occur in the rectifier valves upon switching in as well as in a condition of steady output. It is moreover desirable to obtain a direct voltage which depends as little as possible on the load. From these facts the minimum values may be deduced for the product and the quotient of the self-inductance and the capacity, from which values the value of the quantities themselves may be found.

In addition the influence is discussed of asymmetries on the pulsation of the direct voltage and the considerations which hold in the determination of the number of filter units.

1242*): W. Geiss: Der Einfluss der Spannungsschwankungen auf Glühlampen und Beleuchtung. (Bull. Schweiz. Elektrotechn. Ver. **28,** 225 - 226, May 1937).

In this lecture, given before the Schweizerische Elektrotechnische Verein, the consequences are discussed of the fact that the light flux and the length of life of a filament depend to a large degree upon the voltage to which it is subjected. An incandescent electric lamp which, at 220 volts, has a light flux of 125 decalumens and a guaranteed life of 1000 hours, will, at 231 volts give 150 decalumens and burn only 500 hours, while at 209 volts it gives only 100 decalumens and lasts for 2000 hours. If it is desired, on so-called 220 volt mains, to guarantee an average of 220 volts even for consumers at some distance, the average voltage for a user near a point of distribution may have to be as high as 230 volts. For this consumer lamps intended for 220 volts will of course prove unsatisfactory. It seems obvious that the lamps should be constructed for the average voltage over the whole mains; in this case, therefore, for 225 volts. Since the practice of voltage regulation is not the same for all mains, it is desirable that the conception of what is meant by 220 volt mains should be standardized.

1243: M. J. O. **Strutt**: Characteristic contants of H.F. pentodes. Measurements at frequencies between 1.5 and 300 Mc/s (Wirel. Eng. **14**, 478 - 488, Sept. 1937).

The four fundamental constants of short wave valves are the input and output impedance, slope and feed-back impedance; they are measured by means of a resonance circuit and a diode voltmeter in parallel with it. The manner in which the diode voltmeter is calibrated to 300 Mc/s, and the different measuring arrangements are described. The input impedances up to 300 Mc/s and the output and feed-back impedances up to 60 Mc/s are given for the Philips valves AF 3 and AF 7, the Mullard valves SP4B and VP4B and an acorn pentode. The theoretical derivation is given of the fact that the reciprocal of the resistance and the capacitance in the case of impedances measured during action, must be functions of the square of the frequency. This is also confirmed by experiment. The causes of the decrease in these impedances at higher frequencies are briefly indicated. Finally it is found to be possible to attain a more than fivefold high-frequency amplification for waves of 5 m with the valves AF3 and VP4B.

1244: Balth. van der Pol: Discontinuous phenomena in radio communication (T. Inst. el. Eng., London, **81**, 381 - Sept. 1937).

In this lecture before the radio section of the Institution of Electrical Engineers the advantages are pointed out, in the theoretical treatment of various phenomena in radio, of making use of discontinuous functions, such for example as the unity function of Heaviside, which is zero for all negative values of the independent variable, and at zero value of the independent variable jumps to a value of unity, which it retains further for all positive values of the independent variable. Nonperiodic phenomena can, as a matter of fact, only be described in this way. A detailed treatment is given of one-dimensional wave functions and two-dimensional potential functions with, instead of the usual differential equations, difference equations, which give a deeper insight into all kinds of concepts such as divergence and rotation and line integrals.

1245*): W. Uyterhoeven:Gas discharge lamps with "low pressure" of gas. (Ned. T. Natuurk. **4**, 199 - 216, Sept. 1937).

This lecture was given in the vacation course of the Genootschap voor Verlichtingskunde in 1936, and begins with an explanation of the difference between the mechanism which produces visible radiation in a discharge in sodium and in a discharge in mercury (cf. Philips techn. Rev. **1**, 2 and 70, 1936). The various forms of discharge and the stabilization of the discharge are then discussed. Finally neon lamps, low pressure mercury lamps and different types of sodium lamps are discussed.

1246: W. G. Burgers: Unmittelbare Beobachtung von Gefügeumbildungen bei hohen Temperaturen mit Hilfe des Elektronenmikroskopes (Z. Metallk. **29**, 250 - 251 Aug. 1937).

For the contents of this lecture before the second international congress of the International Association for Testing Materials (London April 1937) compare Philips techn. Rev. **1**, 313 and 321 1936).